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WILLIAM STURGIS THOMAS

FRED J. SEAVER

(WITH PORTRAIT)

One of the recent losses among the members of the Mycological Society of America was Dr. William Sturgis Thomas, who passed away on December 21, 1941. While a physician by vocation, he was a mycologist or a mycophagist by avocation, and his name is doubtless well known to mycologists through the publication of "Field Book of Common Gilled Mushrooms," the first edition of which was published in 1928, a second edition appearing in 1936 under the title "Field Book of Common Mushrooms."

Dr. Thomas was a physician of some note and occupied many prominent positions during his life-time. A full account of these activities appears in the Journal of the New York Botanical Garden for January, 1942. He was a member of the Mycological Society of America from the beginning, and was very active in the organization of the local New York Mycological Society, having been President of that organization up to the time of his death. In this connection he conducted many field trips and was always an inspiration to the large group of amateur mycologists with whom he was associated.

It was the writer's privilege to know him over a long period of years and to have had him as guest in our home. Besides Mrs. Thomas he is survived by a daughter, Mrs. A. T. Jersild, and a son, William Stephen Thomas, who has recently entered the United States Navy.

NEW YORK BOTANICAL GARDEN

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A NEW NON-HELICOID BISPOROUS HELICOCEPHALUM PARASITIZING NEMATODE EGGS

CHARLES DRECHSLER

(WITH 1 FIGURE)

More than half a century ago Thaxter (**4**), then stationed at New Haven, Conn., erected the genus *Helicocephalum* on a curious fungus he described under the name *H. sarcophilum* after discovering it on carrion in a laboratory culture. The fungus was set forth as having the general habit of a large *Mortierella* or *Syncephalis,* its aseptate or rarely septate hyaline mycelium creeping over the substratum and giving rise here and there to tall, erect, continuous, unbranched, gradually tapering, hyaline sporophores supported at the base by rhizoid-like attachments. If the vegetative mycelium and the columnar portion of the sporophore offered little that could be held unusual, the distal portion of the sporophore not only presented remarkable external differentiation in widening out and coiling abruptly two or three times, but also displayed noteworthy internal development by undergoing segmentation into a chain of large, dark brown conidia, which after their disarticulation cohered in a rounded mass.

Spiral coiling in the terminal portion of the sporophore and subsequent segmentation of the helicoid part into a chain of spores which after their disarticulation remain attached in a cohering cluster likewise marked the reproductive development of an obviously congeneric fungus that came to my attention ten years ago in an old agar plate culture originally planted with decaying spinach (*Spinacia oleracea* L.) roots from southeastern Virginia. This species I described as *Helicocephalum oligosporum* (**1**) since it produced commonly 5 to 10 (rarely 11) spores in a head, whereas the Connecticut form had been found bearing as many as 21 spores, seldom more, on the individual fertile hyphae. Besides being produced in lesser numbers, the conidia of *H. oligosporum* were

smaller, measuring mostly 32 to 45 μ in length and 20 to 25 μ in width as compared with a length of 55 μ (maximum 65 μ) and a width of 30 μ (maximum 35 μ) attributed to the spores of *H. sarcophilum*. The sporophores bearing these smaller spores measured only 350 to 600 μ in height and 13 to 16 μ in basal width, as compared with a height of 1 mm. or more and a basal width of 20 to 25 μ recorded by Thaxter. Commensurate with the less robust proportions of its reproductive apparatus my fungus had a more delicate mycelium, its vegetative hyphae measuring only 1 to 1.3 μ in width, as against a hyphal width of 2 μ in *H. sarcophilum*.

A fungus in many ways closely resembling *Helicocephalum sarcophilum* and *H. oligosporum* came to light in several maizemeal-agar plate cultures that after being permeated with mycelium of *Pythium mamillatum* Meurs had received some little addition of partly decayed bluegrass (*Poa pratensis* L.) leaves removed on May 10, 1941, from a heap of old lawn clippings in Arlington, Va. Its conidiophores, somewhat more slender but evidently no less tall than those of Thaxter's fungus, began to appear about a week after the decaying material had been added. Day after day for a period of more than three weeks, during which the temperature of the laboratory varied between 28° and 32° C., new sporophores came up in scattered positions. Eventually the empty membranous remains of old sporophores could be found sparsely distributed here and there in nearly all portions of each culture.

When examined under a microscope of sufficiently high magnification, preferably at a somewhat early stage of development, the individual sporophore was found anchored to the agar substratum by frequently more than a dozen rhizoidal outgrowths extending away in different directions (FIG. 1, *A; B, b; C, b; D, d*). These outgrowths seemed to function only in giving support, for very soon after attaining definitive length they lost their granular contents to persist as empty tubular membranes. A single filamentous branch, less conspicuous than the rhizoidal outgrowths and often only 25 to 50 μ in length, was always found connecting the slightly swollen base of the sporophore with the vegetative mycelium (FIG. 1, *A; B, c; C, c; D, e*). This unpretentious branch represented, of course, the hyphal element from which the entire unit of reproductive apparatus originated, and through which it necessarily had

to receive all its protoplasmic materials. With respect to width the communicating branch and all other mycelial hyphae that likewise remained visible for a long time were coarser than the corresponding filamentous elements of *Helicocephalum oligosporum*, but more delicate than the sterile hyphae of *H. sarcophilum*. Nowhere in the vegetative mycelium were cross-walls found separating masses of protoplasm, though retaining walls were often observed delimiting a portion of living hypha from a contiguous empty portion. In view of the strictly unseptate character of its living mycelium, the fungus must be reckoned among the Phycomycetes no less unreservedly than *H. oligosporum*.

When fully grown the sporophore tapered upward very gradually, often for a distance of about 1 mm., and then widened rather abruptly to form an elongated head that usually came to show a broad, somewhat gradual constriction midway toward the rounded apex (FIG. 1, *A; B, a*). As a rule the head was entirely straight, its axis prolonging that of the supporting columnar shaft (FIG. 2, *A; B, a*); though occasionally some slight curvature was noticeable (FIG. 1, *C, a*). This meager and infrequent curvature may readily have been due to some chance inequality in the pull eventuating from the surface tension of a droplet of clear watery liquid that at an early stage would begin accumulating around the head, especially below the median constriction (FIG. 1, *A; C, a*). With continued extrusion of watery liquid this adhering droplet grew often to a diameter of 100 μ, while simultaneously the elongate head, through insertion of two partitions, one near the base and the other at the constriction, was converted into two spores in end-to-end arrangement. On becoming disarticulated, these spores, now deep brown in color and prolate ellipsoidal in shape, were coerced by the surrounding droplet into a new positional arrangement making them longitudinally parallel and laterally contiguous with one another as well as with the upper portion of the sporophore (FIG. 1, *D, a, b, c*).

As disarticulation inevitably entailed circular rupture of the peripheral membranous layer that originally constituted the sporophore wall (FIG. 1, *E*), the spore of distal origin was found marked at its proximal end by an annular flange-like thickening which appeared in profile as a slight external irregularity. The spore of proximal origin bore a flange-like thickening of similar compass at

its distal end; while at its basal end it was marked by annular thickening of lesser compass (FIG. 1, *E*). In the side-by-side arrangement of the two spores lengthwise along the distal portion of the sporophore (FIG. 1, *D, a; F, a*) the one of proximal origin (FIG. 1, *D, b; F, b*) was usually, though not invariably, found inverted; while the one of distal origin (FIG. 1, *D, c; F, c*) was commonly found in normal posture, with its distal end—the end distinguished by absence of any irregularity in the outer contour of the wall—directed upward. Generally the two spores of a pair were approximately equal in size, yet now and then instances came under observation where one spore was fully a third larger than its mate (FIG. 1, *F, b, c; G, H*).

After remaining erect for perhaps a week the aging sporophores usually fell over, bringing the twin spores into contact with the moist substratum. Germination then often ensued within a few days, usually as in *Helicocephalum oligosporum* by the production of a single germ hypha (FIG. 1, *I*). This single hypha always emerged from a portion of wall laid down as a delimiting septum, never from the more extensive portion of spore wall representing the membrane that originally enveloped the fertile head of the sporophore. Within the circular area laid bare at the time of disarticulation emergence most often was from a peripheral position close to the flange-like modification. By using up the large supply of finely granular protoplasm in the massive spore the germ hypha soon developed into a rather extensive mycelium consisting for the most part of sparingly branched, submerged or prostrate, colorless filaments, 1.5 to 1.9 μ wide,—of filaments, therefore, quite like those making up the mycelium that gave rise to sporophores. However, the younger mycelium could be seen bearing here and there fairly long branches only .7 μ or .8 μ or .9 μ wide, which had no visible counterpart in any mycelium old enough for reproduction. When one of these branches encountered a nematode egg it would give rise, often laterally, to a swollen appressorium that after penetrating the echinulate egg integument introduced an elaborate haustorium composed of handsomely flexuous hyphal elements mostly 2 to 2.7 μ wide (FIG. 1, *J*). Once the haustorium had completely assimilated the materials within the egg, its own

protoplasmic contents were withdrawn backward into the delicate branch, which, from continued retreat of the protoplasm into the wider parent filament, was in turn evacuated, and as a result became indiscernible to ordinary microscopical examination. The delicate branches appeared to constitute a somewhat specialized apparatus whereby the fungus was enabled, with frugal expenditure of its substance, to seek out nematode eggs widely scattered through an extensive mass of substratum. In their exploratory function and early evanescence they resembled the similarly slender branches by means of which the hyphomycete I recently described as *Trichothecium arrhenopum* seeks out and destroys *Pythium* oöspores (3).

The fungus appears remarkable especially for the dimensional extremes found combined in it. For while its exploratory branches are so narrow that they invite comparison with the vegetative filaments of *Actinomyces,* and with the mycelial hyphae of such minute Zoöpagaceae as *Acaulopage rhaphidospora* Drechsl. (2) and *Stylopage lepte* Drechsl. (2), its unicellular spores, fully twice as voluminous as those of *Helicocephalum sarcophilum,* are perhaps the largest aerial asexual spores produced by any phycomycete now known. Apart from the slenderness of its exploratory branches, and the unseptate character of its mycelium, it offers some little parallelism with *Actinomyces* and with several genera of the Zoöpagaceae—the genera *Zoopage, Cochlonema,* and *Bdellospora*—in its catenulate sporulation. This parallelism reaches fuller expression in *H. sarcophilum* and *H. oligosporum,* since these species produce their spores in longer chains which previous to disarticulation are spirally coiled like the spore chains in numerous species of *Actinomyces.*

Although Thaxter's diagnosis of *Helicocephalum* specifies fertile hyphae "spirally coiled at the apex," the fungus parasitizing nematode eggs resembles the helicoid forms so closely in all essential respects that no reasonable doubt can be entertained as to its intimate kinship with them. I am therefore referring it to the same genus, despite its failure to display the remarkable feature signalized in the generic name.

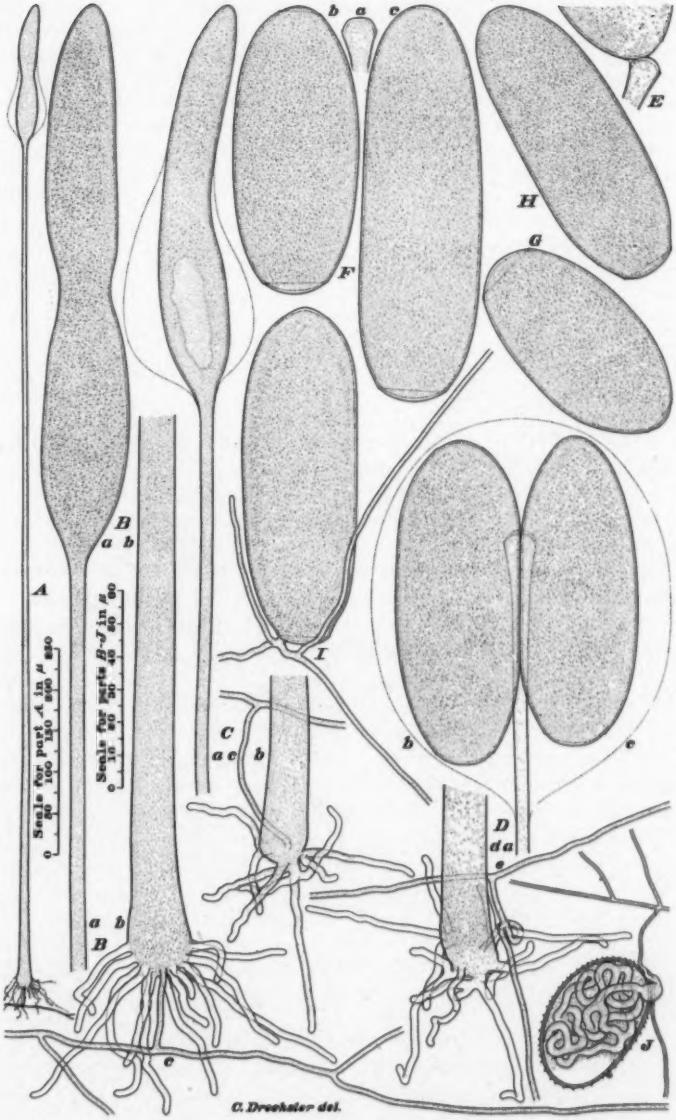

FIG. 1. *Helicocephalum diplosporum.*

Helicocephalum diplosporum sp. nov.

Mycelium parcum, hyalinum, continuum, parve ramosum, in hyphis vivacioribus plerumque 1.5–1.9 μ crassis et ramulis evanidis vulgo .7–.9 μ crassis constans; his tenuibus ramulis in ovum vermiculi nematoidei incasis, appressorium saepius circa 6 μ latum ei applicantibus, putamen eius perforantibus, haustorium intrudentibus; haustorio ramoso, ex filis flexuosis 2–2.7 μ crassis constante. Hyphae fertiles columnares, erectae, continuae, magnam partem hyalinae, 8–20 ramis radiciformibus 10–60 μ longis 2–2.5 μ crassis sustentatae, basi plerumque 14–20 μ crassae, sursum tenuatae, prope apicem 3.5–5.5 μ crassae, capite denuo latescentes etiam fuscescentes, ibi duas sporas in catenulam rectam (numquam in spiram) gignentes, quae postea, catenula diffissa, ad partem superam hyphae fertilis in longitudinem haerent; sporis fulvis, elongato-ellipsoideis, plerumque 70–130 μ longis, 34–39 μ crassis, membrana .5–1 μ (magna parte circa .6 μ) crassa circumdatis.

Ova vermiculi nematoidei interficiens consumensque habitat in foliis *Poae pratensis* putrescentibus in Arlington, Virginia.

Mycelium scanty, colorless, continuous, sparingly branched, consisting of rather long-lived hyphae mostly 1.5 to 1.9 μ wide and of more evanescent branches commonly .7 to .9 μ wide; the narrow branches on encountering a nematode egg producing in contact with it an appressorium, often about 6 μ wide, that perforates the egg integument and intrudes a haustorium composed of flexuous assimilative filaments 2 to 2.7 μ wide. Fertile hyphae columnar, erect, continuous, for the most part colorless, supported below by 8 to 20 rhizoidal branches mostly 10 to 60 μ long and 2 to 2.5 μ wide, above the slightly swollen base 14 to 20 μ in diameter tapering gradually upward to a width of 3.5 to 5.5 μ before widening out into a brownish, elongated, medially constricted, straight or nearly straight, terminal head, which through deposition of two transverse partitions is converted into two spores that after disarticulation adhere lengthwise to the upper portion of the erect column, immersed for some time in a droplet of clear watery liquid; spores brown, elongate ellipsoidal, mostly 70 to 130 μ long, 34 to 39 μ wide, surrounded individually by a wall .5 to 1 μ (mostly about .6 μ) thick.

Destroying and consuming nematode eggs it occurs in decaying leaves of *Poa pratensis* in Arlington, Va.

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EXPLANATION OF FIGURE

FIG. 1. *Helicocephalum diplosporum*, drawn with the aid of a camera lucida; all parts except *A* shown at a magnification of 500 diameters. *A*, Full grown, immature sporophore with lower portion of terminal head surrounded by a droplet of watery liquid; × 125. *B*, Portions of the same sporophore shown at a magnification four times greater: *a*, upper portion, showing the slender proximal attachment and median constriction of the terminal head, the outline of the adhering droplet being omitted; *b*, lower portion, showing distribution of the rhizoidal branches about the slightly bulbous base, and connection of the basal part with the mycelial filament *c*. *C*, Portions of a sporophore almost fully grown: *a*, upper portion, showing slender attachment and slight median constriction of terminal head, as well as envelopment of the wider proximal part of the head in a droplet of watery liquid; *b*, lower portion, showing distribution of rhizoidal branches about the slightly expanded base; *c*, mycelial branch connecting sporophore with the mycelium. *D*, Portions of a fully mature sporophore: *a*, terminal portion to which are adhering the inverted proximal spore *b* and the distal spore *c* with its apex directed upward; both spores being surrounded by a droplet of watery liquid; *d*, expanded basal portion of sporophore, showing its supporting rhizoidal branches as well as the hypha connecting it to the mycelial filament *e*. *E*, Basal portion of proximal spore and tip of mature sporophore, showing manner of disarticulation. *F*, Expanded tip of mature sporophore *a*, flanked by the two spores, *b* and *c*, in usual arrangement,—the proximal spore *b* inverted, the exceptionally long terminal spore *c* in normal posture, with apex directed upward. *G*, An exceptionally short spore of proximal origin. *H*, Spore of average dimensions formed terminally in the same head as *G*. *I*, Spore of proximal origin germinating from its distal end. *J*, Slender exploratory branch with an appressorium from which a haustorium has grown into a nematode egg.

TYPE STUDIES ON BASIDIOMYCETES. II[1]

R. SINGER[2]

The purpose of the following type studies on Basidiomycetes, especially agarics and boletes, has been explained in another paper devoted to the same kind of studies and recently published in Lloydia **5**: 97. 1942. The present series of type studies concerns more especially collections preserved at the N. Y. State Museum, Albany, N. Y., where are located the numerous and extremely important types of Peck's species, described mostly from New York State.

The author is indebted to Dr. Homer D. House of the N. Y. State Museum of Natural History, Albany, who placed the material at his disposal. Some specimens which have been studied at the Farlow Herbarium have been made available through the kindness of Dr. David H. Linder.

RUSSULACEAE

RUSSULA MAGNIFICA Peck, Bull. N. Y. State Mus. **67**: 24. 1903.
Part of type preserved at New York Botanical Garden, another part at New York State Museum.

Spores 7.5–10.3 × 6.2–8 μ, ornamentation type IIIa–VII, or IIIb–VII, more rarely IV–VII, up to 0.3 μ high, hyaline in NH_4OH, asymmetrical. *Cystidia* very numerous, with abundant granular or banded contents, fusoid, with acute or blunt apex or somewhat bottle-shaped, 68–100 × 7–16.5 μ. *Surface of the pileus* consisting of irregularly interwoven hyaline, thin-walled hyphae of 2–3 μ diameter; among them rather numerous laticiferous hyphae are found, some of them having the shape of dermatocystidia. *Margin* of the pileus decidedly acute.

Conclusion: Related to the subsection *Delicinae* and probably identical with *Russula polyphylla* Peck.

[1] The first part of Type Studies has been published in Mycologia **34**: 64. 1942.

[2] Contribution from the Laboratories of Cryptogamic Botany and the Farlow Herbarium, Harvard University, no. 218.

RUSSULA POLYPHYLLA Peck, Bull. Torrey Club **25**: 370. 1898. Type.

Spores 8.5–10.5 × 5.8–8 μ, ornamentation type IIIa–VII, more rarely IIIb–VII, 0.1–0.3–(0.4) μ high, reticulation extremely faint, hyaline. *Cystidia* very numerous with banded contents, mostly acute, but sometimes also attenuate but obtuse, 48–100 × 7–14 μ. *Surface of the pileus* consisting of cylindrical, 4–6.8 μ thick laticiferae with banded, rarely granular contents or contents lacking.

Conclusion: There is every reason to assume that *Russula polyphylla* is the same as *R. magnifica,* Peck having redescribed it as *R. magnifica* when he was able to collect fresh specimens. The description of *Russula polyphylla* apparently was based on dried material and on notes made by the collector.

RUSSULA COMPACTA Frost & Peck apud Peck, Ann. Rep. N. Y. State Mus. **32**: 32. 1880. Type, and fresh material from Purgatory Swamp, Norwood, Mass., compared with the type.

Pileus white, later between "avellaneous" and "cinnamon Buff" (R.), the cuticle separable on the outer half of the pileus, opaque, very faintly rimulose, or not, eventually often cracking, umbilicate, then infundibuliform; *surface of the pileus* consisting of cylindrical, interwoven, hyaline or yellowish, thin-walled hyphae (up to 0.6 μ thick), without any contents and therefore not laticiferous, 2.7–6.7 μ in diameter; diameter of the pileus 75–150 mm.; *lamellae* milk white, very crowded, arcuate-concave, but broadest in the outer (marginal) third, rather narrow: 8 mm. broad, very little anastomosing, very strongly intermixed with lamellulae but not at all polydymous, many lamellae forked particularly near the stipe, almost obtuse on the margin (about 90°) when mature, emarginate-free; becoming dark gray with aniline oil; spore print white (Crawshay A); spores from the deposit 7–10 × 6.5–8.3 μ, ornamentation type IIIa, IIIb, IV (rarely), VIII (exceptionally) 0.3–0.5 μ high. *Cystidia* with a strange body in its contents which is rather small and very well visible in sulfovanilline but becomes only indistinctly blue in this reagent; subhymenium consisting of cellulae passing into the well developed hymenopodium, consisting of divergent normal hyphae; mediostratum cellular with few normal hyphae intermixed. *Stipe* white, thick and cylindrical, with a large cavity when mature, firm, smooth (not rugulose). *Context* white, immediately and strongly staining brown when exposed to the air, be-

coming about the same brown as old specimens of *Russula xerampelina;* taste mild; odor of trimethylamine, after a while becoming mixed with a cacodyle-like odor; sulfovanilline becoming chocolate brown (normal reaction); aniline oil: quickly rufous brown; $FeSO_4$: immediately green; formol: no reaction. *Habitat:* In mixed woods, on fairly humid places under frondose and coniferous trees, mostly in summer. Rather frequent.

Conclusions: A comparison of the descriptions of *R. compacta* and *R. polyphylla* (Syn.: *R. magnifica*) would lead to the supposition that the species are identical but a study of the type show them to be distinguishable even by their macroscopical characters by which they may be separated as follows: in *R. compacta* the pileus tends to be fulvous, with blunt margins, and the lamellae become gray on drying, while in *R. polyphylla* the pileus tends to be buff colored, to have conspicuously acute margins, and the lamellae are brownish. The above is supplemented by the writer's previous description (Bull. Soc. Myc. France **54**: 141. 1938). In addition to the type, there is preserved at Albany a specimen collected by Davis in Boston, Mass. that was determined as *R. compacta* but is in reality *R. xerampelina* (Schaeff.) Fries.

RUSSULA ECCENTRICA Peck, Bull. N. Y. State Mus. **150**: 61. 1911. Type.

Only two poorly prepared specimens are preserved; they are the same as Kauffman's plant (compare Singer, Bull. Soc. Myc. France **55**: 227. 1939). The conclusion therefore is the same as for these specimens.

RUSSULA GRANULATA Peck, Ann. Rep. N. Y. State Mus. **53**: 843. 1900. Type.

This is exactly the same as *Russula obtecta* Sing. (Bull. Soc. Myc. France **55**: 234. 1939), which consequently becomes a synonym of *R. granulata.* All descriptive data and commentaries, made on *Russula obtecta,* are valid for *R. granulata.*

RUSSULA FOETENTULA Peck, Bull. N. Y. State Mus. **116**: 85. 1907. Type.

Spores 8.3–10 × 7.3–8.2 μ, ornamentation type IV, more rarely IIIb, V, VI, sometimes II–IV, IV–VIII, the spines distributed irregularly (0.8) 0.9–1.1 (1.4) μ high. *Cystidia* very numerous.

Conclusion: This is *Russula foetens* var. *minor* Sing., Bull. Soc. Myc. France **54**: 135. 1938.

RUSSULA ANOMALA Peck, Ann. Rep. N. Y. State Mus. **50**: 99. 1897. Type.

Spores 9.3–10 × 7.7–8.2 μ, ornamentation type VI, rarely V, spines 0.6–1.2 μ high. *Basidia* 37 × 6.5–7.5 μ, 4-spored. *Cystidia* numerous, very thick, with banded contents, clavate to fusoid, mostly bluntly rounded, 70 × 14–16 μ. *Trama* with numerous spherocysts.

Conclusion: This is a species of the *R. citrina–R. Raoultii–R. albida–R. innocua*-group of *Ingratae,* differing from *R. albida* and *R. inocua* in acrid taste, and from *R. citrina* and *R. Raoultii* in echinulate, not reticulate spores. My previous identification of this species with the white form of *R. emetica* ssp. *fragilis* was a mistake, although Peck's short description permits such an interpretation.

RUSSULA CRUSTOSA Peck, Ann. Rep. N. Y. State Mus. **39**: 41. 1887. Authentic material.

I was not able to identify the type specimen from Day, N. Y. The rather abundant authentic material preserved at Albany is a mixture of different species. A sheet of specimens collected at Port Jefferson belongs to *Russula crustosa* sensu Kauffman (*i.e. R. cyanoxantha* var. *variata*), another sheet from Whitehall, N. Y., belongs to a species close to the one described by the writer (Bull. Soc. Myc. France **55**: 240. 1939) as *Russula crustosa* Peck sensu Coker. It is, however, somewhat different from the latter, and therefore the notes on Peck's Whitehall material follows:

Pileus greenish, finally fading to brownish; subcutis consisting of 2–2.8 μ thick hyphae and scattered laticiferae of 3.5–7 μ diameter, epicutis consisting of a pseudoparenchyma; the cells are for example 16 μ in diameter and bear a rather short hair-like proliferation that frequently is septate and about 4 μ in diameter. *Cystidia* with or without contents, 6.5–8.5 μ thick. *Spores* 7–8.5 × 6–7.5 μ,

ornamentation type IIIa (b)–VIII, the warts 0.3 μ high. *Context* becoming very bright purplish red with sulfonvanilline.

This same species has been collected in Purgatory Swamp, Norwood, Mass., in fresh condition. The cystidia become almost entirely blue in sulfovanilline, the context becomes orange in $FeSO_4$.

RUSSULA MODESTA Peck, Bull. N. Y. State Mus. **116**: 78. 1907. Type.

Spores 6.7–7.3 × 5.8–6 μ, ornamentation IIIb–IV (the larger ones often VI), with very thin connecting lines, and rather dense to scattered up to 0.7 μ high warts. *Basidia* 26 × 7.5 μ. *Cystidia* 80 × 9–14 μ, fusoid or subcylindrical, blunt or acute, with abundant banded content. *Cheilocystidia* scattered along with actual cystidia on the edge of the lamellae, needle shaped or subulate, with 0–2 septa on the very apex which easily breaks off, without contents, 45–55 × 2.5–7.5 μ. *Epicutis* consisting of scattered clavate 50–95 × 6.5–10.5 μ large dermatocystidia and very numerous hairs with thin to medium thick (0.6–0.8 μ) walls and blunt tips, the base of the hairs originating from a subglobose basal cell, or a series of such cells (9 × 8 μ, 18 × 9 μ, 15 × 10 μ, etc.). These cells are smaller than they usually are in the *Virescens*-group, but more marked than in the *Vesca*-group. *Hyphae* of the subcutis thin-walled, long, hyaline, 2–3.5 μ thick.

Conclusion: This species reminds one of *Russula Mariae* as well as of *R. virescens* and even *R. grisea* and *R. furcata*. *R. modesta* seems to be rather ambiguous between the stirpes of the subsection *Chlorinae* on one hand, and the subsection *Virescentinae* on the other hand. The material described from the Great Smoky Mountains in 1939 (Bull. Soc. Myc. France **55**: 245–246. 1939) very probably belongs to the same species as Peck's original *R. modesta*.

RUSSULA ALBELLA Peck, Ann. Rep. N. Y. State Mus. **50**: 101. 1897. Type.

Spores 7.5–9.3 × 6–6.3 μ, ornamentation type IIIa, more rarely IIIb, the warts 0.5–0.7 μ high, the connecting lines mostly thin. *Basidia* 34 × 7.5–11.5 μ. *Cystidia* 55–66 × 9–10 μ, with banded content, fusoid or cylindric-fusoid, or bottle-shaped, the ones on the edge of the lamellae appendiculate, the appendix about 6 μ long. *Epicutis* with moderately numerous dermatocystidia which are clavate, stuffed with banded content, 65–82 × 4.5–9 μ.

Conclusion: This is a very rare species and not well enough known to make any conclusive statement upon its position. Nevertheless the data furnished from a study of the type should be sufficient for identification of fresh material that finally will help to locate *R. albella.*

RUSSULA PURPURINA Schulzer, sensu Peck, non Schulzer. Authentic material, collected and determined by Peck, compared with fresh material from Newcomb Co., N. Y.

As I have mentioned in an earlier paper (Bull. Soc. Myc. France **55**: 250–250. 1939), *Russula purpurina* of the American authors is not identical with anything found in Europe. This species has to be renamed. The following name is proposed:

Russula Peckii Sing. sp. nov. Pileo rubro vel rarius roseo, subviscido, subpruinoso in statu sicco, 35–77 mm. lato. Dermatocystidiis nullis, sed pilis microscopicis numerosis, granulis paucis sulfovanillina ope subnigrescentibus impletis atque hyphis primordialibus numerosis in epicute obviis. Lamellis albis, demum subflavescentibus, aequalibus. Stipite plus minusve concolori. Carne alba, rubella sub cute, miti, inodora, solutione aquatica phenolica ope grisea. Habitatio: Sub coniferis. Observatio: Ad subsectionem *Lepidinae* pertinet. Typus est collectio Peckii primaria, co-typi sunt collectiones posterae (North Elba, N. Y., Piseco, N. Y., etc.).

Fresh material of *R. Peckii* has been studied by the writer and some remarkable features of this beautiful plant are worthy of mention: The reaction with phenol is unique among the agarics, or at least the Russulae. Phenol stains the context "Benzo brown" to "deep Quaker drab" or "dark purplish grey" or "dark Quaker drab," reaching eventually "Aniline black." The "amorphous body" in the cystidia, mentioned in my description (l.c.), and also the granulae found in many of the hairs of the epicutis stain blue to blackish blue in sulphovanilline. Consequently *R. Peckii* is one of the most outstandingly characterized species in *Russula,* anatomically as well as chemically, and should be easily recognized. It always grows under coniferous trees.

RUSSULA LUTEOBASIS Peck, Bull. Torrey Club **31**: 179. 1904. Type.

Spores pale yellowish under the microscope in ammonia, 7.8–11.3 × 6–9 μ, very variable in a single preparation, ornamentation

type likewise varying: II, IIIa, IIIb, IV, V, VIII, more rarely VII–IX, the warts up to 0.7 μ high. *Basidia* 27–37 $\times$ 10–13 μ. *Cystidia* 62 $\times$ 6.5–10 μ, with loose banded or granular content, fusoid, not numerous; cheilocystidia without contents, mostly about 41 $\times$ 4–5.5 μ large and rather versiform. *Epicutis* consisting of long rows of primordial hyphae, the terminal members rounded-blunt and often covered with a yellowish incrustation, sometimes with moderately thickened walls, sometimes one member somewhat bloated, but mostly 3.5–6 μ in diameter.

Conclusion: This remarkable species belongs in the subsection *Olivaceinae,* along with such species as *R. borealis* and *R. pseudo-integra.*

RUSSULA NIGRESCENTIPES Peck, Bull. Torrey Club **33**: 214. 1906. Type.

Pileus a very bright red but not shining; epicutis consisting of hairs; the hairs arising from a thicker (about 6.5 μ) ovoid basal cell, the terminal member oblong or mostly cylindrical and about 2–4.5 μ thick, some of them somewhat incrusted, some with granular, and some even with banded contents, so forming a transition toward dermatocystidia, though actual dermatocystidia lacking. *Lamellae* somewhat yellowish in dried condition; spores 6.7–9.5 $\times$ 5.7–7.5 μ, ornamentation type II, IIIb, more rarely IIIa, IV, II–IV, the warts or ridges 0.3–0.6 μ high, mostly 0.5 μ and rather cylindrical than pyramidal as far as warts are concerned, many spores somewhat yellowish in NH_4OH, almost as much as in *Russula pulchella; basidia* 27–32 $\times$ 9.5 μ. *Cystidia* not very distinct. *Stipe* abruptly black at base.

Conclusion: *Russula nigrescentipes* Peck has been placed in the section *Decolorantes,* subsection *Decolorantinae,* by the writer (1926, 1932, 1935). This certainly is the proper position of Peck's species although it is not quite certain that the spores are white, as indicated by its author.

RUSSULA FLAVICEPS Peck, Ann. Rep. N. Y. State Mus. **53**: 843. 1900. Type specimens, and authentic material.

The type specimens are not homogenous. One part of them does not agree very well with the original description given by Peck, since it shows reddish hues on the pileus and rather deep

yellow lamellae, suggesting some form close to *Russula Schiffneri* Sing. The other part of the type specimens is *Russula flava* Rom. In another (authentic) collection from Lake Pleasant, N. Y., are only specimens very much like *R. flava* (called *R. constans* Karst. in most other cases), but with no sign of any part of the fruit bodies staining gray. In the writer's opinion, it is rather safe to consider *R. flaviceps* Peck a mere synonym of *R. flava* Rom. Peck apparently called the forms that were not yet gray, *R. flaviceps,* and the gray ones *R. constans.*

RUSSULA NIGRODISCA Peck, apud J. M. Macoun in D. S. Jordan, Fur Seals N. Pacif. **3**: 583. 1889. Type.

Spores 9–10.5 × 7.4–8.2 μ, ornamentation type IIIa, sometimes II–IIIa, the network consisting of coarse and fine lines, very dense, the lines crossing each other, the warts dense, 0.3 μ high. *Basidia* 41 × 13 μ; sterigmata four, 6–7 μ long. *Cystidia* about 62 μ long and 7.5–14 μ thick, rather variable in length, numerous. *Dermatocystidia* very abundant.

Conclusion: This plant is an arctic form of *Russula emetica,* and does not seem to be different from *Russula emetica* ssp. *alpestris* (Boud.) Sing. which is rather common in the Arctic as well as in the alpine region of many high mountain ranges (Alps, Caucasus).

RUSSULA BLACKFORDAE Peck, Bull. N. Y. State Mus. **139**: 43. 1910. Type, and fresh material from Newcomb Co., New York, compared with the type.

In the first part of these studies, Mycologia **34**: 89–90, 1942, the type specimens preserved at the Farlow Herbarium were examined. Later, the part of the type specimens deposited at the N. Y. State Museum were examined and compared with fresh material collected in Newcomb Co., N. Y. I am now in a position to identify *R. Blackfordae* with sufficient certainty. There is no doubt that the species called *Russula serotina* Quél. sensu Melz. & Zvára or *Russula versicolor* J. Schäffer are exactly identical with *R. Blackfordae.* Since the emendation of *R. serotina* by Melzer

and Zvára was made subsequent to the publication of *R. Blackfordae,* the latter has clear priority over *R. versicolor* J. Schäffer, the American name must be used.

RUSSULA PALUSTRIS Peck, Ann. Rep. N. Y. State Mus. **53**: 842. 1900. Type, and also fresh material, collected in Newcomb Co., N. Y., compared with the type.

Macroscopical comparison, anatomical and chemical characters show that this species is identical in every regard with what is called *Russula exalbicans* (Secr.) Melz. & Zv. by European writers. But recently other names have been preferred to Secretan's name, because Melzer and Zvára's fungus only possibly, not necessarily, belongs to *Agaricus exalbicans* of Secretan. When proposing the name *R. depallens* Fries for the same species, J. Schäffer only gave one uncertain name for another. Borszczow's pictures of *Russula pulchella* Borsczc., however, are very suggestive of *R. palustris* Peck, and since no types were found in the Herbaria of the U. S. S. R., I tried, in September 1940, to find the species in the type locality, near Gaczina, Province of Leningrad, and was lucky enough to collect what hitherto I had called *R. exalbicans,* and what here has been called *R. palustris.* Borszczow claims in his description that his species is mild. Many specimens of this *Russula* are found either almost mild or even completely mild when old, when collected under certain weather conditions. It seems to me therefore that the most appropriate name for it is *Russula pulchella* Borszcz. with *R. exalbicans* sensu Melzer & Zvára and *R. palustris* Peck as synonyms (compare Borszczow, E. Fungi Ingrici Novi vel Minus Cogniti Iconibus Illustrati. Petropoli. 1857).

Some other species of *Russula* which have been studied before by the writer, although the studies were not based on the type specimens or on portions of the type only, have been restudied together with the specimens mentioned above. The results follow:

R. VARIATA Bann. ap. Peck, identical with the form described in Fedde's Repertorium **33**: 351. 1934. [*R. cyanoxantha* var. *variata* (Peck) Sing.]

R. AERUGINASCENS Peck, a colored form of the preceding.

R. OCHROPHYLLA Peck = *R. olivacea* (Schaeff.) Fries (compare Bull. Soc. Myc. France **55**: 252. 1939.

R. DECOLORANS Fries sensu Peck, non Fries. A mixture of different *Decolorantinae,* mostly *R. decolorans* Fries var. *rubriceps* Kauffman which, however, is a good autonomous species, **R. rubriceps** (Kauffm.) Sing. comb. nov.

TRICHOLOMATACEAE

LACCARIA STRIATULA Peck, Bull. N. Y. State Mus. **157**: 93. 1912; *Clitocybe* (Laccata) *striatula* Peck, Ann. Rep. N. Y. State Mus. **48**: 274. 1897. Type.

Spores globose or subglobose, spinose, 10.5–12.8 × 9.5–11.5 μ. Spines up to 1.6 μ high. *Basidia* 40–52 × 9–10 μ, 2-spored.

Conclusion: This species is not identical with the specimens collected and studied for North American Flora by Murrill, nor are they identical with an externally very similar species that I collected in the Altai Mts., and determined as *"Laccaria striatula* Peck." However, both Murrill's and my plant are rather close to Peck's original *L. striatula.* Murrill's plant has been collected by the writer in 1941 in Van Cortlandt Park, N. Y. It differs in being 4-spored, and the average size of the fruit bodies probably is a little less than in Peck's type. The Altaian form differs in having spores of the same size but with much shorter spines. Since Murrill's and my *"L. striatula"* are distinct from what Peck called *L. striatula,* they have to be renamed or described as new. But the genus *Laccaria* has not yet been studied sufficiently, and it seems difficult, at least at present, to determine valid specific characters in this genus.

CLITOCYBE CARNOSIOR Peck, Ann. Rep. N. Y. State Mus. **23**: 76. 1872. Type.

The comparison of the type specimens and fresh material collected by the writer in the Adirondack Mts., shows that *C. carnosior* actually is the same as *Clitocybe clavipes* (Pers.) Fries.

CLITOCYBE ADIRONDACKENSIS Peck, Ann. Rep. N. Y. State Mus. **23**: 77. 1872. (*Agaricus.*) Type.

The comparison of the type specimens and other collections with fresh material collected by the writer in the Adirondack Mountains shows that this is a good species of *Clitocybe*.

CLITOCYBE MACULOSA Peck, Bull. Buffalo Soc. Nat. Sci. **1**: 45. 1873.

The comparison of the type specimens and fresh material, collected in the Adirondack Mountains, with European material of *Clitocybe gilva* (Pers.) Fries, shows that both these species are identical.

The spores are small, subglobose and distinctly warty-rough. This species belongs to the *Inversa*-group.

AGARICUS (*Tricholoma*) DECOROSUS Peck, Bull. Buffalo Soc. Nat. Sci. **1**: 42. 1873. Authentic material, collected by Farlow at Shelburne, N. H.

Spores 5–5.5 (6.3) × 3.3–3.5 μ, non-amyloid, smooth. *Basidia* 21–24 × 5.3–5.8 μ, 4-spored. *Cheilocystidia* present, large. Clamp connections present. *Hyphae* of the epicutis very large, about 24 μ broad. General appearance suggesting *Pholiota squarrosoides*.

Conclusion: This species belongs to the genus *Tricholomopsis*. The new combination **Tricholomopsis decorosa** (Peck) Sing. is proposed.

AGARICUS SULFUREOIDES Peck, Ann. Rep. N. Y. State Mus. **23**: 86. 1872. Type and also material collected by Kauffman in Michigan, and fresh material from the Adirondack, Mts., N. Y.

All the collections cited seem to be identical and have the following characters in common:

Spores 6.5–7.5 × 5–6.7 μ, with one oil drop, subglobose, hyaline, non-amyloid. *Basidia* 28–40 × 5.8–7.5 μ, 4-spored. *Cheilocystidia* balloon-shaped or clavate-subacuminate, 45–55 × (6.8) 12–28 μ, brown, numerous. *Hyphae* with clamp connections.

Conclusion: This evidently belongs in *Tricholomopsis,* but it does not seem to be a good species. It is hardly more than a variety of what the writer called *Tricholomopsis ornata* (Fries) Sing. in Europe and Asia. Therefore the combination **Tricholomopsis ornata** var. **sulfureoides** (Peck) Sing. comb. nov. is proposed.

OMPHALIA OLIVARIA Peck, Bull. Buffalo Soc. Nat. Sci. **1**: 48. 1873. Type.

Spores 6.5–8.5 × 4–6 μ, hyaline, smooth, non-amyloid. *Basidia* 32.5 × 7 μ, 4-spored. *Cystidia* none. *Trama* of the lamellae regular. *Hyphae* without clamp connections, non-amyloid.

Conclusion: The microscopical characters show that this species belongs to the *Umbellifera*-group of the genus *Omphalia* sensu stricto. I have mentioned this species in a previous paper as occurring in Spain. My Spanish specimens (compare Ann. Myc. **34**: 428. 1936) are somewhat different from the colored sketch that accompanies the type, and also differ from the description in some smaller details. The lamellae particularly are much narrower in Peck's figure than they are in my specimens, but the specimens have undoubtedly considerably broader lamellae than shown on the figure. I do not think that the Spanish form is specifically different from the American type.

HYGROPHORUS MARGINATUS Peck, Ann. Rep. N. Y. State Mus. **28**: 50. 1876. Type, and also from fresh material collected in the White Mts., N. H.

This species has very much the appearance of a *Hygrocybe,* but because of the lack of clamp connections it differs from other members of the Hygrophoraceae except for the closest relatives which I term the *Marginata* group. Since, because of the absence of clamp connections, *H. marginata* does not belong to the Hygrophoraceae, it is necessary to transfer the species elsewhere. The only clampless groups with identical micro-structure are *Armellariella* and *Tricholoma* subgen. *Eu-Tricholoma.* The latter is macroscopically nearer to the *Marginata* group since it contains species of which the lamellae are brightly colored and not infre-

quently comparatively thick, as in *Tricholoma* (*Eu-Tricholoma*) *sulphureum* with thick lamellae, *T. orirubens* with red lamellae, and several other species which show these same characters. I do not give more descriptive data because of the excellent description in a recent paper by Smith and Hesler (Lloydia **5**: 39. 1942). An equally good description by Kühner (Le Botaniste **17**: 53. 1926) does not mention clamp connections but it appears from the figures accompanying the description that Kühner's does have clamp connection. This fact, together with other differences shown by the French material, lead me to assume that Kühner's species is probably a *Hygrocybe,* but the type of Peck's *H. marginatus* cannot be placed in that genus and I therefore propose the binomial **Tricholoma marginatum** (Peck) Sing. comb. nov.

TRICHOLOMA SUBLUTEUM Peck, Bull. N. Y. State Mus. **75**: 21. 1904. Type.

Spores 6.7–7 × 5.3–6.5 μ, very short ellipsoid to globose, with a rather thin wall, smooth, hyaline, mostly with 1 small oil drop, non-amyloid. *Basidia* 29.5–39.5 × 6.5–10 μ, 4-spored. *Cystidia* none. *Hyphae* of the cuticle subparallel, hyaline, with no pigment visible under oil immersion lens, without clamp connections, rather thin: 0.5–3.5 μ thick.

Conclusion: *Tricholoma subluteum* belongs in the subgenus *Eu-Tricholoma.*

TRICHOLOMA PLANICEPS Peck, Bull. N. Y. State Mus. **42**: 112. 1889. Type.

Spores 7–7.5 × 5–6 μ, very distinctly warty, the warts strongly amyloid, leaving a smooth spot above the hilum on the inner side of the spore (plage), ornamentation type IV–VI, V. *Basidia* 27–35 × 8–9.5 μ, 4-spored, a part of them 2-spored. *Cheilocystidia* basidiomorphus. *Cystidia* fusoid or capitate-bottle-shaped, very rare and inconspicuous, 27.5–30 × 5 μ. *Trama* of the lamellae filamentous, almost regular, the hyphae without clamp connections. Observation: In the type specimen there are a few Lactarius-spores intermixed which can easily be recognized in Melzer's reagent, where they show a different type of ornamentation: I (reticulate-cristate).

Conclusion: Murrill (N. Am. Flora **10**: 7. 1914) identified *Tricholoma planiceps* with *Melanoleuca melaleuca.* The type of *T. planiceps* does, however, not agree with *M. melaleuca* unless an extremely broad conception of this latter species is admitted. Therefore, the combination **Melanoleuca planiceps** (Peck) Sing. comb. nov. is proposed.

MELANOLEUCA ALBOFLAVIDA (Peck) Murr., N. Am. Flora **10**: 6. 1914, non Singer, Cavanillesia **7** (6–9): 123. 1935. *Agaricus* Peck, Ann. Rep. N. Y. State Mus. **23**: 75. 1872. Peck's types and other authentic materials, Murrill's collections and authenticated material at the N. Y. Botanical Garden and fresh material from Huntington Forest, Newcomb Co., N. Y., collected by R. Singer, and compared with the type material.

Pileus white with a honey yellow center, or "pinkish buff" to "warm buff" (R.) all over, convex, soon flat, but frequently bluntly umbonate, 46–73 mm. broad. *Lamellae* sordid-greyish-yellow (very pale), very crowded, emarginate, sinuate, medium broad: 5–7 mm. broad. *Spores* 8–9.5 × 4.5–5.4 μ, hyaline under the microscope, but creamy white (about B, Crawshay) in mass, ellipsoid, with small, but distinct isolated warts, decidedly amyloid. *Basidia* 26.5–37 × 7–8.5 μ, 4-spored. *Cystidia* fusoid or more often subulate, acute, more rarely obtuse, the thickest part 9–15 μ thick (mostly 10–11 μ in diameter), 45–65 μ long, hyaline, with rather thin walls, abundant on the edge of the lamellae, less abundant near the edge, and mostly lacking on the sides, the apex with or without the needle shaped barb-like crystals. Stipe pale at apex, white to pale greyish brown in the middle, white to greyish brown on the base, fibrillose and somewhat turned, 50–93 × 4–11 mm. (at apex) 6–18 mm. (at base), slightly thickened to decidedly bulbous at base. *Context* whitish to subconcolorous at some places. Taste mild. Odor none, or slightly recalling the odor of *Inocybe geophylla* or flowers of *Berberis vulgaris.* Becoming moderately quickly and intensely violet with methylparamidophenol (reaction decidedly positive). Hyphae thin, without clamp connections. Habitat: Mostly in deciduous woods.

Conclusion: When adopting the name *Melanoleuca alboflavida* for the European species, called *Tricholoma cnista* by Bresadola, I relied on the statement of Bresadola who gave the first indication

of the identity of the American species with the European one. But studies on American material show that the species called *Melanoleuca alboflavida* by American authors is quite different from the European plant. This latter is a species growing in the subalpine meadows of the Alps, the Pyrenees, the Caucasus and has pure white spore powder when the print is made on white paper. The spores of *Melanoleuca alboflavida* have a creamy spore powder, and grow in woods or more or less open places but near deciduous trees in lower altitudes (up to 3000 feet). In previous type studies (Lloydia **5**: 122. 1942), I have shown that *Collybia sedula* Graff is a *Melanoleuca*. When comparing Graff's types with Peck's types, and the description of *Collybia sedula* with my notes on fresh material of *Melanoleuca alboflavida*, I came to the conclusion that both these species are identical. Consequently *Collybia sedula* is a synonym of *Melanoleuca alboflavida*, while *Melanoleuca alboflavida* sensu Singer, non Peck, becomes a synonym of *Melanoleuca evenosa* (Sacc.) Konrad (= *Tricholoma cnista* sensu Bres. non Fries.).

MARASMIUS UMBONATUS Peck, Bull. Buffalo Soc. Nat. Sci. **1**: 58. 1873. Authentic material, coll. Macoun, det. Peck, ex Herb. Ellis, FH.

Hyphae of the cuticle almost smooth, repent, filamentous.

Conclusion: This is a species of *Collybia*, not a *Marasmius*, and since there is another *Collybia umbonata* Peck (Bull. Torrey Club **31**: 178. 1904) the name of *Marasmius umbonatus* has to be changed. The new name **Collybia umbonatella** Sing. nom. nov. is proposed.

COLLYBIA LACUNOSA Peck, Ann. Rep. N. Y. State Mus. **44**: 176. 1891. Type, and fresh material, collected by R. Singer in the Adirondack Mts., compared with the type.

LENTINUS CHRYSOPEPLUS Berk. & Curt., Jour. Linn. Soc. **10**: 301. 1868. Type in Curtis' Herbarium (FH), and recently collected materials from Brazil, coll. and det. Rick as an unpublished new species, older material from São Paulo and Porto Novo, Brazil, det. Patouillard (*M. aculeatus*).

Agaricus scabriusculus Peck, Ann. Rep. N. Y. State Mus. **23**: 85. 1872. Type.

Marasmius aculeatus Pat., Bull. Soc. Myc. France **16**: 175. 1901. Type, and authentic material from Guadeloupe, coll. Duss, det. Patouillard, 1903.

The types of all these species have been studied. They have the following microscopical characters in common, and no differentiating macroscopical features of specific value have been discovered:

Spores 7.5–10.5 × 5–7.8 μ, hyaline, smooth, ellipsoid-lemon-shaped, sometimes all thin-walled, sometimes some of them more or less thick-walled, sometimes subangular, with no or indistinct depression, non-amyloid. *Basidia* very narrow, 40–50 (61) × 6–7 μ. *Cystidia* 50–55 (75) × 9.5–10 (13) μ, clavate, more rarely ventricose, thick-walled or thin-walled. *Hyphae* non-amyloid, with clamp connections. *Floccose covering* of the pileus consisting of a palisade of erect hairs; hairs clavate, 18–100 × 7–15 μ, from yellowish hyaline to very bright yellow, thick-walled, the walls 1.7–3.5 μ thick, consisting of two layers, the outer layer non-amyloid, the inner thicker layer sometimes being pseudoamyloid, the connecting septum between the clavula and the last hypha bearing a clamp, the clavula itself sometimes branched near the septum. *Hairs of the stipe* 50–100 × 8–10 μ, some slightly pseudoamyloid, but the majority not pseudoamyloid, similar in shape and color to the hairs of the pileus.

Conclusion: This species does not belong to any of the many genera to which it has been referred by authors. The thick-walled hairs of the covering layers suggest a *Crinipellis* but the reaction with iodine is much too slight where it is observed at all, and the hairs are arranged in palisade-like clusters. Its characters agree fairly well with the generic characters of the genus *Xerula*, and the writer thinks that it has to be ranged in this genus. The oldest specific name being that of Berkeley and Curtis, the new combination **Xerula chrysopepla** (Berk. & Curt.) Sing. comb. nov. is proposed. The writer has not seen any specimens referred to *Agaricus* (*Pleurotus*) *aureotomentosus* Kalchbr. ap. Kalchbr. & Cooke (Grevillea **9**: 17. 1880) except for one collection in the Patouillard Herbarium (FH) from New Caledonia, coll. Le Rat, det. "*Marasmius aureotomentosus* (*Pleurotus, Kalchbr.*) = *M. aculeatus*

Pat." by Patouillard. Since Patouillard himself identifies his species with Kalchbrenner's African species, and the original description of the Port Natal plant agrees well enough with the material collected in the Western Hemisphere, I am inclined to think that it belongs to the same species. A more orange color—in contrast with *X. chrysopepla* which is about "light cadmium"—is shown in De Seynes' picture (*pl. 3, fig. 8–10*) of his *Clitocybe verruculosa* (compare also the description of De Seynes in Champignons du Congo français **1**: 7. 1897), but since the other characters seem to agree with the characters of *Agaricus aureotomentosus,* it probably is nothing but a color variation of *Xerula chrysopepla.*

Consequently, the synonymy of *Xerula chrysopepla* (Berk. & Curt.) Sing. would consist of the following binomials:

Lentinus chrysopeplus Berk. & Curt. (1868).

Agaricus scabriusculus Peck (1872).

Agaricus (*Tricholoma*) *lacunosus* Peck (1873).

Agaricus (*Pleurotus*) *aureotomentosus* Kalchbr.; Kalchbr. & Cooke (1880).

Omphalia scabriuscula Sacc. (1887).

Tricholoma lacunosum Sacc. (1887).

Pleurotus aureotomentosus Sacc. (1887).

Collybia lacunosa Peck (1891).

Clitocybe verruculosa De Seynes (1897)—a variety?

Marasmius aculeatus Pat. (1901).

Gymnopus chrysopeplus Murr. (1916).

This list of synonyms shows that Murrill (N. Am. Flora **5**: 359 and 376. 1916) gave an almost complete picture of the synonymy of this fungus. His statements are confirmed by the writer's type studies.

AGARICUS TENUIPES Schwein. Syn. Am. Bor. 147. 1832.

Agaricus rhabarbarinus Berk. Jour. Bot. & Kew Misc. **8**: 135. 1856. Authentic material in Curtis Herbarium (FH).

Marasmius amabilipes Peck, Bot. Gaz. **4**: 216. 1879. Type and authentic material.

The cited specimens are identical in every regard with the species described in Lloydia **5**: 127. 1942. They are, consequently,

synonyms of what is called *Gymnopus tenuipes* (Schwein.) Murrill in North American Flora. The writer has not seen authentic specimens of this latter species, but C. G. Lloyd seems to be very positive on the identity of *Agaricus tenuipes* and *Marasmius amabilipes,* and since this opinion is not seriously opposed by any strong argument but on the contrary, seems to be accepted by a majority of authors, the writer believes that Schweinitz's name can be used for the species in question, and therefore the new combination **Heimiomyces tenuipes** (Schwein.) Sing. comb. nov. is proposed.

AGARICUS (COLLYBIA) SPINULIFERUS Peck, Ann. Rep. N. Y. State Mus. **24**: 62. 1872. Authentic material from the Burt Herbarium (FH).

This is identical, in every regard, with European material of *Marasmius cohaerens* (Pers.) Quél. (= *Marasmius ceratopus* (Pers.) Quél.).

AGARICUS SUCCOSUS Peck, Bull. Buffalo Soc. Nat. Sci. **1**: 46. 1873. Type specimen and authentic material.

Mycena atramentosa v. Höhnel, Frag. Myc. **3** (no. 97), 1907. Material of the von Höhnel Herbarium (FH).

The above mentioned materials are identical, as suggested by Kühner. The following anatomical description will complete the description given by Kauffman & Kühner (Kühner, Le genre Mycena, p. 532, 1939), Bresadola (Icon. Myc. *pl. 216, fig. 1.* 1928), and v. Höhnel (l.c.).

Spores 4.2–6 × 3.2–4.5 μ, very shortly ellipsoid, with slight or no depression, hyaline or frequently becoming brown on the lamellae, with thin, amyloid walls, smooth. *Basidia* about 6.5 μ broad. *Cheilocystidia* mostly rather variable in size, from 3.5–16 μ broad, hyaline or brownish, incrusted or not, very numerous, filamentose-cylindrical, filamentose-claviform, filamentose-ampullaceous, or vesiculose-balloon shaped. *Cystidia* none. *Laticiferae,* which are everywhere numerous, on the surfaces and edges of the black lamellae, frequently discolor large portions of tissue, basidia and even spores that become brownish to dark fuligineous. *Epicutis* similar to the surface layer of **Hydropus marginella** (Pers.)

Sing. comb. nov. [*Omphalia marginella* aut.] and its variety var. *rugosodiscus* (Peck) Joss. & A. H. Smith, but the bodies of the epicutis seem to be unequally distributed and rather transitory, and may sometimes be replaced by small irregular, strongly incrusted elements. In the subcutis very numerous black or blackish-brown granulose laticiferae, and hyphae with a distinct membrana-pigment. *Hyphae* of the trama non-amyloid.

Conclusion: The above data prove that *Mycena fuliginaria* (*Collybia succosa, Mycena atramentosa*) belongs to the genus *Hydropus*. The combination **Hydropus fuliginarius** (Batsch.) Sing. comb. nov. is proposed.

PANUS DEALBATUS Berk., London Jour. Bot. **6**: 317. 1847. Material from Curtis Herbarium (FH) that must at least be authentic (Ohio), and more recently collected material from Ohio (Morgan), determined by Peck.

Spores 6–9.5 × 2.3–4 μ, mostly 6.5–7.5 × 2.7–3.3 μ, cylindrical, subfusoid, or somewhat curved, smooth, hyaline, non-amyloid, very thin-walled, with one central oil drop. *Basidia* 19–21 × 4–5.5 μ, thin-walled except for the upper half with a medium thick (about 0.5 μ) wall, sometimes the wall is up to 2.5 μ thick, and then the basidia are sterile. *Gill trama* consisting of strongly and irregularly interwoven filamentose, about 2 μ thick, thin-walled hyphae with a tendency, in some specimens, to protrude into the hymenial layer among the basidia; clamp connections present. *Surface layer of the pileus* consisting of hyaline 2.5–3.5 μ thick hyphae with spine-like short branches of 3.5–6 μ length and about 1 μ diameter on their base, their axis mostly forming an angle of about 90° with the main hypha, the terminal branches of each hypha often shorter and stellate, about 1.5 μ long, all branches with more or less blunt tips, the hyphae walls about 0.6 μ thick.

Conclusion: This extraordinary fungus is not related to any other species of the genus *Panus* nor to another known genus. The structure of the surface layer of the pileus is unique in the Agaricales, and can be compared only with the structure of the genus *Vararia* (*Asterostromella*) in the Aphyllophorales. It is true that the organization of the hymenophore shows a great variety in the genus *Vararia*. Thus Bondarzew and Singer (Ann. Myc. **39**: 48. 1941) referred the "Poria" *P. luteopora* Bond. to *Asterostromella*, but since D. P. Rogers has shown that *Vararia*

Karst. has priority for this group, the combination **Vararia luteopora** (Bond.) Sing. comb. nov. should be used. Nevertheless, it does not seem that actual natural relations exist between *Panus dealbatus* and *Vararia*. *Marasmius cohaerens* and an undescribed new species of Boletaceae from Liberia that I have studied recently, have typical setae, but they are neither related one to another, nor are they related to setae bearing Polypores (*Inonotus, Phellinus, Cyclomyces*) or Corticiineae (*Hymenochaete, Hydnochaete, Asterodon,* etc.). Thus, it has to be admitted that the so-called "*Asterostromella*-structure" occurs among the Agaricales, *Panus dealbatus* being the first and only species in which it has been discovered. Since *Panus dealbatus* differs from other genera of Pleurotoideae where it could be ranged, if the anatomy of the pileus is neglected, I propose the following genus for this striking species:

Asterotus Sing. gen. nov.

Pileo flabelliformi. Stipite laterali, compresso. Contextu molliter subcoriaceo. *Strato superficiali pilei ex hyphis structuram generis Vararíae revocantibus composito.* Sporis oblongiusculis levibus, hyalinis, inamyloideis. Basidiis saepe crassotunicatis ad apicem. Cystidiis nullis. Trama lamellarum e hyphis tenuitunicatis vel mediocriter tunicatis, valde intertextis, tenuibus efformata. Hyphis non gelatinosis, fibuligeris, hyalinis. Ad ligna. —Species typica: *Panus dealbatus* Berk.

For *Panus dealbatus,* the new combination **Asterotus dealbatus** (Berk.) Sing. comb. nov. is proposed.

AMANITACEAE

AMANITA FROSTIANA Peck, Ann. Rep. N. Y. State Mus. **33**: 44. 1883. Type.

Spores 5.5–10 × 5–7 μ, short ellipsoid, some almost subglobose, smooth, non-amyloid. *Gill trama* bilateral.

Conclusion: While Peck and Atkinson as well as Kauffman considered *Amanita Frostiana* Peck and *Amanita flavoconia* Atkinson as distinct species, it has been suggested by Murrill (1914), Coker (1917) and others that both these species be mere synonyms. The iodine reaction shows that they are not only good species, but

belong to different subgenera: *A. Frostiana* Peck belongs to subgenus *Pseudoamanita* Sing. (1936), together with *A. muscaria* (L.) Pers., and *A. flavoconia* Atk. belongs to subgenus *Euamanita* Sing. (1936) because of its amyloid spores.

CORTINARIACEAE

PHOLIOTA DUROIDES Peck, Bull. N. Y. State Mus. **122**: 148. 1908. Type.

Spores 4–6.3 × 3–4.5 μ, subellipsoid to ovoid, pale honey color, smooth, without germ pores. *Cystidia* few or lacking on the sides of the lamellae, but numerous on the edge, clavate, with a yellow refringent amorphous body in the broadest part. *Epicutis* of the pileus consisting of repent radial, filamentose, smooth, scarcely or somewhat mucilaginous, rather parallel, 4.5–6.5 μ thick hyphae, with clamp connections.

Conclusion: This species has typical *Flammula*-cystidia, and therefore cannot be ranged in *Pholiota* merely because of the presence of an annulus, an evidently secondary character. The writer has pointed out that *Flammula Freindlingiae* Sing. although distinctly annulate, is a species of *Flammula* (compare Beih. Bot. Centralbl. Abt. B, **46**: 170. 1936). **Flammula duroides** (Peck) Sing. comb. nov. differs from *F. Freindlingiae* in brighter colors and lacking or with but slight viscosity of the cuticle.

TUBARIA LUTEOALBA Longyear, Bot. Gaz. **28**: 272. 1899. Type specimens from Albany.

Under this name, the writer has published a collection from the Caucasus Mts. (Beih. Bot. Centralb. Abt. II, **48**: 531. 1931) which however belongs to *Cortinarius* (see Rev. de Myc. **4**: 72. 1939). The American types of this species are very much like my Caucasian material in general appearance, and their original description fits them rather well, but the spores are not rough, they have rather thin walls and so little pigmentation that they appear almost hyaline. Their measurements, as found in the Albany types, are 7–9.5 × 4.5–4.8 μ. This species, consequently, cannot be a *Cortinarius*, but most probably is an actual *Tubaria*.

AGARICUS TILIOPHILUS Peck, Ann. Rep. N. Y. State Mus. **35**: 133. 1884. Type, and fresh material, compared with the type, collected by W. L. White & R. Singer in Purgatory Swamp, Norwood, Mass.

The following description covers abundant fresh material as well as the type collection:

Pileus watery brown and somewhat hygrophanous, buffy brownish when dry, not viscid, somewhat pruinate or faintly rivulose at last, the margin subincurved when young, transparently striatulate when moist, largest diameter of the convex pileus 8–25 mm.; dermatocystidia numerous, forming the faint pruinosity of the pileus, the epicutis not hymeniform, the dermatocystidia forming the terminal members of ascendent or erect hyphae of the subcutis, very similar to the cheilocystidia of the hymenium, hyaline or brown, rather thin-walled although with thicker walls than the basidia, often curved, broad cylindrical, clavate, or sometimes bottle-shaped, 16–36 × 4.5–8 μ; hyphae of the subcutis mostly colored, with a membrana pigment, horizontal, subparallel. *Lamellae* argillaceous brown, very broad, moderately close, adnate or adnexed; spore print on white paper dirty brownish; spores 6.5–8 × 4.2–5.5 μ, ovoid, rather pale under the microscope, smooth, with rather thin, not distinctly double wall, germ-pore not seen; basidia 16.3 × 6.5 μ; cheilocystidia almost exactly like the dermatocystidia but mostly clavate, 25–40 × 4.5–10 μ; cystidia lacking. *Stipe* pale brownish, sometimes whitish or light buff, somewhat longitudinally fibrillose, often distinctly white pubescent at base, equal or subequal, straight or more often curved, eventually hollow, eccentric or central, 5–20 × 1–5 mm. *Context* almost concolorous, thin, inodorous, consisting of strongly interwoven, almost intermixed hyphae. *Habitat:* Gregarious, on dead wood and branches of *Tilia americana* and other frondose trees.

Conclusion: The characters of this species refer it to *Naucoria* Fries sensu stricto Sing. rather than to *Crepidotus*. Thus, the new combination **Naucoria tiliophila** (Peck) Sing. comb. nov. is proposed.

NOTES ON THE USTILAGINALES OF THE WORLD III [1]

GEORGE L. ZUNDEL

(WITH 4 FIGURES)

The following new species have been found from specimens recently received while working on the Ustilaginales of the world. Some corrections are also included in this paper:

USTILAGINALES OF SOUTH AFRICA

Additional specimens from the Union Department of Agriculture, Mycological collection, Pretoria, have given the following new species and new hosts for old species.

1. **Ustilago Ehrhartana** Zundel, sp. nov.

Sori destroying the inflorescence, at first covered by a delicate membrane of host tissue which disintegrates exposing a dark-brown, powdery spore-mass; spores globose to broadly ellipsoidal, olivaceous-brown, with an epispore 1.5–2 μ thick, chiefly 10.5–14 μ in diameter, smooth.

Soris inflorescentiam destruentibus, primo tenui membrana ipsius inflorescentiae tectis, membrana dissoluta massam sporarum fusco-brunneam atque pulverulentam ostendit; sporis globosis vel late ellipsoideis, olivaceo-brunneis, episporo 1.5–2 μ crasso, plerumque 10.5–14 μ diam., levibus.

Hab. in *Ehrharta erecta* Louv. var. natalensi Stapf.

On *Ehrharta erecta* Louv. var. *natalensis* Stapf, on mountain top, in the shade of a large *Fiscus,* Ingwavuma district, Natal. Coll. O. West (*915*), Nov. 29, 1938 (U. D. *30501*).

[1] The Latin descriptions in this paper were kindly written by Dr. Robert E. Dengler, Prof. Classical Languages, The Pennsylvania State College, and acknowledgments are hereby given. Any errors are to be charged to the author.

Contribution from the Department of Botany, The Pennsylvania State College, No. 134, State College, Centre Co., Pa.

2. **Ustilago Eragrostidis-japonicana** Zundel, sp. nov.

Sori in the ovaries, minute, ovate, about 1 mm. or less in diameter; spores chiefly globose to subglobose, somewhat irregular, olivaceous-brown, chiefly 7–8 μ in diameter, minutely verruculose.

Soris in ovariis, minutis, ovatis, 1 mm. plus minusve diam.; sporis plerumque globosis vel subglobosis, aliquantum irregularibus, olivaceo-brunneis, plerumque 7–8 μ diam., minute verruculosis.
Hab. in *Eragrostide japonica* Trin.

On *Eragrostis japonica* Trin., Welgelegen, Vryburg district, Cape Province. Coll. G. A. Pentz, April 1925 (U. D. *20621*).

3. **Ustilago Liebenbergii** Zundel, sp. nov.

Sori destroying the inflorescence, hidden by the upper leaf sheaths, covered by a membrane which ruptures exposing a black powdery spore-mass; spores globose to broadly ellipsoidal, somewhat irregular, semi-opaque, chiefly 10.5–14 μ diameter, smooth.

Soris inflorescentiam destruentibus, vaginis superioribus folii celantibus, membrana rupta massam atram pulverulentamque sporarum detegit; sporis globosis vel late ellipsoideis, aliquantum irregularibus, semi-translucidis, plerumque 10.5–14 μ diam., levibus.
Hab. in *Chloride virgata* Sw.

On *Chloris virgata* Sw., Vlakfontein, Wolmaransstad district, Transvaal. Coll. L. C. C. Liebenberg, July 1932 (U. D. *26412*).

4. **Ustilago Mariscana** Zundel, sp. nov.

Sori destroying the ovaries, ovate, protected by the enveloping flower parts, powdery, spore-mass dark-brown; spores globose to subglobose, ellipsoidal or elongated, somewhat irregular, olivaceous-brown, chiefly 10.5–13 μ diameter, smooth.

Soris ovaria destruentibus, ovatis, a partibus floris amictis, pulverulentis, massa sporarum fusco-brunnea; sporis globosis vel subglobosis, ellipsoideis vel elongatis, aliquantum irregularibus, olivaceo-brunneis, plerumque 10.5–13 μ diam., levibus.
Hab. in *Marisco sieberiano* Nees., etc.

On *Mariscus sieberianus* Nees., Infulzane, Melmoth district, Natal. Coll. by A. O. D. Mogg (*6096*), Dec. 1, 1919 (U. D. *33062*).

5. **Ustilago Tragana** Zundel, sp. nov.

Sori in the ovaries, swollen, ovate, 2.5–3 mm. in diameter, covered by a tough greenish membrane which ruptures exposing a dark-brown, powdery spore-mass; spores chiefly subglobose to broadly ellipsoidal, occasionally globose, olivaceous-brown, chiefly 8.5–10.5 μ in diameter, abundantly echinulate.

Soris in ovariis, tumentibus, ovatis, 2.5–3 mm. diam., membrana dura et subviridis rupta massam fusco-brunneam pulverulentamque sporarum ostendit; sporis plerumque subglobosis vel late ellipsoideis, interdum globosis, olivaceo-brunneis, praecipue 8.5–10.5 μ diam., abundanter echinulatis.
Hab. in *Trago racemoso* All., etc.

On *Tragus racemosus* All., Potgietersust district, Transvaal. Coll. Dr. I. B. Pole-Evans about March 1936 (U. D. *28708*) (Type); Hollandsdrift, Pietersburg district, Transvaal. Coll. A. M. Bottomley, April 26, 1937 (U. D. *28784*).

6. **Ustilago Trichoneurana** Zundel, sp. nov.

Sori in the upper leaves and culms as short striae, about 1 to 2 cm. long, covered by a membrane which ruptures freeing a dark-brown, powdery, spore-mass; spores globose to subglobose often irregular, bright olivaceous-brown, chiefly 6.5–8 μ in diameter, smooth.

Soris striaformibus in foliis superioribus et culmis, ca. 1–2 cm. longis, membrana rupta massam fusco-brunneam atque pulverulentam sporarum detegit; sporis globosis vel subglobosis, saepe irregularibus, dilute olivaceo-brunneis, plerumque 6.5–8 μ diam., levibus.
Hab. in *Trichoneura grandiglumi* Stapf et Hubb.

On *Trichoneura grandiglumis* Stapf & Hubb., Edendale, Pretoria district, Transvaal. Coll. by A. O. D. Mogg, Nov. 28, 1929 (U. D. *22844*).

7. **Ustilago Urochloana** Zundel, sp. nov.

Sori destroying the ovaries, ovate, about 2 mm. long, protected by the glumes, covered by a delicate membrane which ruptures freeing a dark-brown granular spore-mass; spores irregularly globose to subglobose, sometimes angled, light reddish-brown, chiefly 8.5–10.5 μ in diameter, apparently smooth but very minutely verruculate under high magnification.

Soris ovaria destruentibus, ovatis, ca. 2 mm. longis, a glumis tectis, membrana delicata rupta massam sporarum fusco-brunneam et granularem de-

tegit; sporis irregulariter globosis vel subglobosis, interdum angulatis, dilute rubro-brunneis, plerumque 8.5–10.5 μ diam., apparenter levibus vero minute verruculatis sub immersione ut dicunt olei visis.
Hab. in *Urochloa trichopo* Stapf.

On *Urochloa trichopus* Stapf, Brown's Kuil Drift, Crocodile River, Transvaal. Coll. by A. O. D. Mogg, June 8, 1921 (U. D. *20690*).

8. SOROSPORIUM CONSANGUINEUM Ellis & Ev.

On *Lodetia simplex* (Nees) Hubb., Meintjies Kop, Pretoria, Union of South Africa. Coll. A. O. D. Mogg, March 18, 1930 (Union Dep. Agr. Myc. No. *25314*).

9. ENTYLOMA FUSCUM Schröt.

On *Papaver Rhoeas* L., Berea, Durban, Natal, Union of South Africa. Coll. A. P. D. McClean, Dec. 22, 1938 (Union Dep. Agric. Myc. No. *30453*).

CHINESE USTILAGINALES COLLECTED IN COÖPERATION BETWEEN THE FARLOW HERBARIUM OF HARVARD UNIVERSITY AND THE UNIVERSITY OF NANKING

1. **Ustilago anhweiana** Zundel, sp. nov.

Sori destroying the inflorescence, globose about 3 mm. diameter, forming a yellowish-brown, dusty, spore mass; spores globose to subglobose, regular, olivaceous-brown, chiefly 7–11 μ diameter, with rather fine winged reticulations.

Soris inflorescentiam perdentibus, globosis, ca. 3 mm. diam., massa sporarum pulverulenta, fusco-brunnea; sporis globosis vel subglobosis, regularibus, olivaceo-brunneis, plerumque 7–11 μ diam., minute reticulatis.
Hab. in *Polygono* sp. Ping Tou Ssu, etc.

On *Polygonum* sp., Ping Tou Ssu, Ch'ing Yan Hsien, Chin Hua Shan, Anhwei Prov., China. Fungi of Anhwei Province, China No. *1496*. Coll. S. Y. Cheo, XI/7/1932.

2. USTILAGO EGENULA Syd. & Butler

On *Eragrostis tenella* (L.) Beauv., T'ien T'ai Wan Ch'ing Yang Hsien, Chiu Hua Shan, Anhwei Prov., China. Coll. S. Y. Cheo, Oct. 14, 1932, No. *1247*.

3. **Sphacelotheca Cheoana** Zundel, sp. nov.

Sori destroying scattered ovaries in the panicle, ovate, flattened, covered by a delicate brown membrane, spore mass semi-powdery surrounding a short columella; sterile cells abundant, hyaline, in twos or short chains, often having a yeast-like appearance, globose to elongate often irregular chiefly 5–8 μ diameter, smooth; spores globose to ellipsoidal, regular, olivaceous-brown, chiefly 7–10 μ long, minutely and abundantly echinulate.

Soris ovaria dispersa perdentibus, ovatis, planis, membrana delicata et brunea; massa sporarum semi-pulverulenta brevique collumellae circumstante; cellulis sterilibus, abundantibus, hyalinis, duplicibus vel catenatis, speciem fermenti saepe praebentibus, globosis vel elongatis, saepe irregularibus, plerumque 5–8 μ diam., levibus; sporis globosis vel ellipsoideis, regularibus, olivaceo-brunneis, plerumque 7–10 μ longis, minute et abundanter echinulatis.

Hab. in *Eragrostide cilianensi* (All.) Link.

On *Eragrostis cilianensis* (All.) Link, Sha Kan, Ch'ing Yang Hsien, Chu Hua Shan, Prov. Anhwei, China. Fungi of Anhwei Province, China No. *1392*. Coll. S. Y. Cheo, X.24.1932.

4. SPHACELOTHECA SCHWEINFURTHIANA (Thüm.) Sacc. var. **minor** Zundel, var. nov.

Differs from the species by the smaller spores which are 7–9 μ diameter, otherwise agreeing with the species.

A specie differt maxime sporis minoribus, 7–9 μ diam.
Hab. in *Saccaro arundinaceo* Ritz, etc.

On *Saccharum arundinaceum* Retz., Ta Tseh Tsuen, Yung Hsien, Kwangsi Province, China. Coll. S. Y. Cheo, 5–VIII, 1933 (Fungi of Kwangsi Province, China, No. *2362*).

NOTES CONCERNING USTILAGO CARBO COLUMELLIFERA TULASNE, ANN. SCI. NAT. III 7: 81. 1847

In 1847 Tulasne in his memoir on the Ustilaginales coined the name *Ustilago Carbo columellifera* giving a very imperfect description and giving a long list of hosts. In 1910, McAlpine when working on his Smuts of Australia found a specimen in the National Herbarium collected at Rochampton, Queensland, labeled *Ustilago Carbo* var. *columellifera* on *Andropogon australis* Spreng.

After studying this specimen McAlpine concluded that it was a *Cintractia* and changed the name to *Cintractia columellifera* (Tul.) McAlp.[2]

In 1928 Ciferri apparently worked with a similar fungus and published the name *Sphacelotheca columellifera* (Tul.) Ciferri[3]

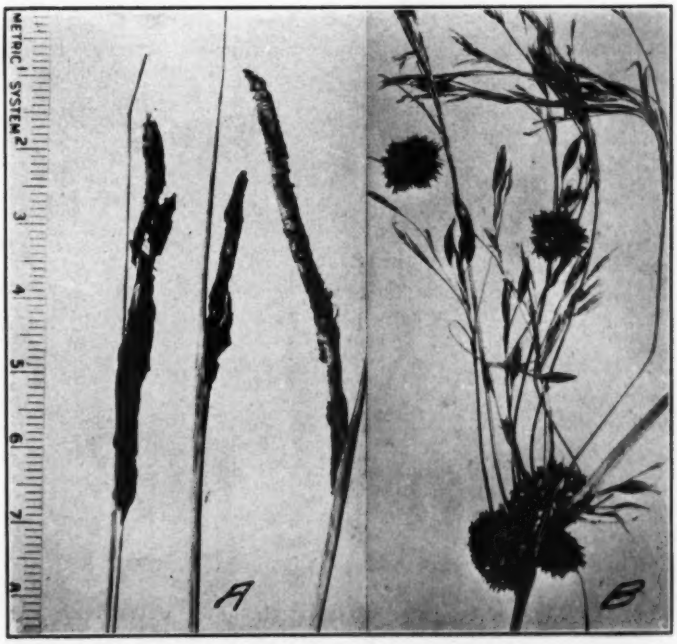

FIG. 1. *A, Sphacelotheca McAlpineae* Zundel, on *Trachypogon mollis*, Brazil. Poto by Kribs. *B, Cintractia Standleyana* Zundel. Type. Photo by Kribs.

without giving a description or source of material. In 1930, Zundel[4] accepted this name using a specimen labeled *Cintractia columellifera* from New South Wales on *Andropogon intermedius* R. Br. as a basis for this acceptance. Furthermore, Zundel[5] in

[2] McAlpine, D., Smuts of Australia 166. 1910.
[3] Ann. Myc. **26**: 32. 1928.
[4] Mycologia **22**: 139. 1930.
[5] Mycologia **25**: 353. 1933.

1933 working with a Brazilian smut on three species of *Trachypogon* found that this smut was identical to the one on *Andropogon* from New South Wales and therefore used the name *Ustilago Carbo columellifera* Tul. for the Brazilian smut.

Yen [6] in 1937 working in Paris published the name *Sphacelotheca columellifera* Yen on *Andropogon Lanigeri* Desf. from Morocco.

Since the description published by Yen did not agree with those previously published by McAlpine and Zundel, type specimens were requested from the Tulasne herbarium in Paris. Two specimens were received and were found to belong to two different genera viz., a *Sphacelotheca* and a *Sorosporium*. These specimens also differed from the Australian, the Brazilian and the Morocco specimens. Zundel [7] therefore named the Tulasne specimens *Sphacelotheca transfissa* and *Sorosporium trichophorum*. The Australian specimen was then named *Sphacelotheca McAlpineae* Zundel and the Yen specimen was named *Sphacelotheca Yenii* Zundel. The Yen specimen was later found to be identical to *Sphacelotheca Lanageri* (P. Magnus) Maire.

More material of the smut on *Trachypogon* has recently been sent in for study and the specimens previously reported as *Sphacelotheca columellifera* (Tul.) Ciferri in Mycologia **25**: 353. 1933, have been reexamined. All were found to agree with *Sphacelotheca McAlpineae*. The South American distribution of this smut is as follows:

On *Trachypogon canescens* Nees, campo, altitude 700–725 meters, Casa Branca, São Paulo, Brazil. Coll. Agnes Chase, Jan. 16, 1930. Plants of Brazil No. *10598½*.

On *Trachypogon mollis* Nees, open campo summit, altitude 1,100–1,500 meters, Pocos de Caldas, Minas Geraes, Brazil. Coll. Agnes Chase, Jan. 18–20, 1930. Plants of Brazil No. *10628*, also Buritys, near Rio São Francisco, Minas Geraes, Brazil. Coll. Agnes Chase, Jan. 1, 1930. Plants Brazil No. *10452½*.

On *Trachypogon Montufari* (H. B. K.) Nees, sandy campo, altitude 300–325 meters, Tres Lagoas, Motto Grasso, Brazil. Coll. Agnes Chase, Feb. 4–5, 1930. Plants of Brazil No. *10721½*; San Juan de los Morros, Estado. Guarico, Venezuela. Coll. A. S.

[6] Rev. Myc. n.s. **2**: 76. 1937.
[7] Zundel, G. L. Mycologia **31**: 581. 1939.

Müller, April 27, 1938 (Ministerio de Agric. y Cria, Estac. Exper. de Agric. y Zooecnia No. *2155*).

USTILAGINALES OF CENTRAL AND SOUTH AMERICA

Additional new species and other collections in Guatemala and Venezuela are reported as follows:

1. **Cintractia Standleyana** Zundel, sp. nov.

Sori destroying the ovaries and converting them into a loose powdery spore-mass, groups of infected ovaries becoming distorted and swollen at intervals along the stem; spores globose to broadly ellipsoidal, regular, dark reddish-brown, chiefly opaque, 12–15.5 μ diameter, indistinctly but abundantly pitted to almost reticulate.

Soris ovaria perdentibus et in laxam pulverulentamque massam sporarum convertentibus; ovariis infectis inde distortis et passim per caulem tumentibus; sporis globosis vel late ellipsoideis, regularibus, fusce atrobrunneis, plerumque opacis, 12–15.5 μ diam., parum clare sed abundanter maculatis vel paene reticulatis.

Hab. in *Rhynchospora glauca* Vahl, etc.

On *Rynchospora glauca* Vahl, Dept. Alta Verapaz, Guatemala: Large swamp east of Tactic, alt. about 1450 m. Coll. Paul C. Standley, April 14, 1941. Standley Field Expedition of Field Museum of Natural History, Plants of Guatemala No. *92624*.

Farysia Chardoniana Zundel, sp. nov.

Sori infecting individual spikelets throughout the inflorescence, globose, usually solitary 4–5 mm. diameter, spore-mass brown interspersed with numerous elaters; spores globose to broadly ellipsoidal, occasionally irregular, light reddish-brown, chiefly 5–8 μ diameter, abundantly verruculate and frequently spirally or longitudinally striate.

Soris singulas spiculas per totam inflorescentiam inficientibus, globosis, plerumque solis, 4–5 mm. diam., massa sporarum numerosis elateribus ut dicunt distincta; sporis globosis vel late ellipsoideis, interdum irregularibus, dilute rubro-brunneis, plerumque 5–8 μ diam., abundanter verruculatis et saepe in cochleam vel longitudinem striatis.

Hab. in *Carice polystachya*.

On *Carex* sp., Mountain above Hacienda Cura (1500 m.) state of Carabobo (type). Coll. Carlos E. Chardon and A. H. G. Alsten,

Myc. Explor. of Venezuela, Cornella University No. *2772;* on *Carex polystachya* Sw.; Dept. Jalapa. Brushy oak slopes of Cerro Alcoba, east of Jalapa, alt. 1400–1500 m. Coll. Paul C. Standley, Nov. 13, 1940, Standley Field Expedition of Field Museum of Natural History, Plants of Guatemala No. *77219;* Dept. Chimaltenango: Along road between Chimaltenango and San Martin Jilotepeque, alt. 1500–1700 m. Coll. Paul C. Standley, Dec. 22, 1940, Standley Field Expedition of Field Museum of Natural History, Plants of Guatemala No. *80871.*

3. FARYSIA OLIVACEA (D. C.) Sydow.

On *Carex polysticha* Boeckl., Dept. Baja Verapaz: Along margin of the big swamp below Pantin, alt. about 1575 m. Coll. Paul C. Standley, April 4, 1941.

4. MYCOSYRINX CISSI (D. C.) G. Beck.

On *Cissus sicyoides* L., between Rio Jute and Rio Pantaleon, on the road between Escuintla and Santa Lucia Cotz, Dept. Escuintla, alt. 540–720 m. Coll. Paul C. Standley, Jan. 24, 1939, Sewell Avery Expedition of the Field Museum of Natural History, Plants of Guatemala No. *63503;* Dept. Santa Rosa: Near Cuilapa, alt. about 895 m. Coll. Paul C. Standley, Stanley Field Expedition of Field Museum of Natural History, Plants of Guatemala No. *77984;* Dept. Retalhuleu: Vicinity Retalhuleu, alt. 240 m. Coll. Paul C. Standley, Standley Field Expedition of Field Museum of Natural History, Plants of Guatemala No. *88603.*

5. **Farysia venezuelana** Zundel, sp. nov.

Sori infecting and destroying most of the inflorescence, globose, spore-mass black interspersed by numerous elaters; spores globose to subglobose, rarely ellipsoidal, regular, reddish-brown, chiefly 7.5–10.5 μ diameter, thickly verruculate.

Soris inflorescentiam inficientibus et paene perdentibus, globosis, massa sporarum nigra et multis elateribus ut dicunt distincta; sporis globosis vel subglobosis, rare ellipsoideis, regularibus, rubro-brunneis, plerumque 7.5–10.5 μ diam., dense verruculatis.

Hab. in *Carice* sp.

On *Carex* sp., along high mountain road from Caracas toward Colonia Tovar, Venezuela. Coll. H. H. Whetzel and A. S. Müller, March 12, 1939, Exper. de Agric. y Zootecnia. No. *3015*.

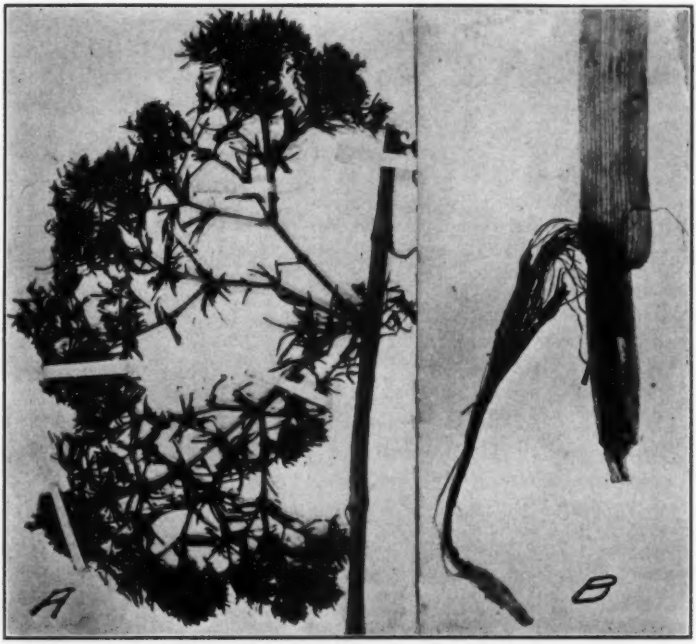

FIG. 2. *A, Mycosyrinx Cissi* (D. C.) G. Beck on *Cissus sicyoides*, Central America. Photo by Kribs. *B, Sorosporium Lindmanii* Zundel. Type. Photo by Kribs.

6. THECAPHORA HAUMANI Speg.

On *Iresine Celosia* L., Dept. Chimaltenango: Finca La Alameda, near Chimaltenango, alt. about 1830 m. Coll. Paul C. Standley, Dec. 11–22, 1940, Stanley Field Expedition of Field Museum of Natural History, Plants of Guatemala No. *79914*.

7. **Sorosporium Lindmanii** Zundel, sp. nov.

Sori destroying the inflorescence, long, linear, 15–18 cm. long, 5–7 mm. wide, at first partially protected by the leaf sheath, cov-

ered by a yellowish-white false membrane which flakes away revealing a dark brown, powdery spore-mass intermixed with long elater-like shreds; sterile cells of the false membrane in chains, hyaline, oblong and flattened on the side of contact, usually giving a cuboid appearance, chiefly 9–14 μ long, thick epispore; spore-balls globose to oblong, many spored, opaque, semi-permanent, dark-brown, 40–90 μ long; spores globose to subglobose, regular, light reddish-brown chiefly 4–7 μ diameter, smooth.

Soris inflorescentiam perdentibus, longis, linearibus, 15–18 cm. longis, 5–7 mm. latis, primum in vagina foliorum partim celatis atque membrana falsa fusco-albaque tectis, quae membrana in squamas rupta atro-brunneam massam sporarum longis et elateroideis pannulis commixtam detegit; cellulis falsae membranae sterilibus et in catenas dispositis, hyalinis, oblongis et latere contingente obtusis, plerumque cubicis, maxime 9–14 μ longis, episporio crasso; massa sporarum globosa vel oblonga, sporis numerosis, opaca, semi-permanente, atro-brunnea, 40–90 μ longa; sporis globosis vel subglobosis, regularibus, lucide rubro-brunneis, plerumque 4–7 μ diam., levibus.

Hab. in *Oplismenopide najada* (Hack. et Arch.), etc.

On *Oplismenopis najada* (Hack. & Arch.) Parodi (*Panicum najadum* Hack. & Arch.), in the forest on the banks of the river Riacho Mbopi, Paraguay. Coll. Nov. 19, 1893, by C. A. M. Lindman. Herb. Brazil, Regnell. Mus. bot. Stockholm, Exped. 1mae Regnellian Fungi No. *B331*.

This specimen was collected by C. A. M. Lindman in Paraguay in 1893. O. Juel reported it as *Ustilago* sp. in "Die Ustilagineen und Uredineen der ersten Regnellschen Expedition, Bihang till K. Svenska Vet-Akad. Handl. Band 23, Afd. III. No. 10, Stockholm 1897 and says "In der Inflorescenz eines unbestimmten Grases. Paraguay, in silvula riparia Riacho Mbopi." Mrs. Agnes Chase kindly identified the host as reported here.

TWO MISCELLANEOUS SMUTS FROM NEW GUINEA AND THE PHILIPPINE ISLANDS

1. **Sphacelotheca Polliniana** Zundel, sp. nov.

Sori usually destroying all of the ovaries, long, linear, 2–3 cm. long, at first covered by a dark brown fragile membrane which disintegrates exposing a dusty spore-mass surrounding a simple columella; sterile cells about the size of the spores, tinted brown, chiefly in twos or chains, globose, irregular; spores globose to subglobose, regular, olivaceous-brown, chiefly 11–14 μ diameter, smooth.

Soris plerumque ovaria perdentibus, longis, linearibus, 2–3 cm. longis, primum membrana atro-brunnea et fragile coopertis, membrana disintegrans massam sporarum pulverulentam simplici columellae circumstantem exponit; cellis sterilibus eandemque fere magnitudinem atque sporae habentibus, brunneis, plerumque binis vel catenatis, globosis, irregularibus; sporis globosis vel subglobosis, regularibus, olivaceo-brunneis, plerumque 11–14 μ diam., levibus.
Hab. in *Pollinia leptostachyde* Pilger, etc.

On *Pollinia leptostachys* Pilger, Morobe, Kajabit Mission, New Guinea. Flora of New Guinea, Clements Expedition No. *10633*. Coll. M. S. Clements, August 31, 1939. Mrs. Agnes Chase kindly determined the host.

2. **Sphacelotheca benguetensis** Zundel, sp. nov.

Sori in the ovaries, elongate, about 1–1.5 cm. or more in length, 1 mm. wide, covered by a dark-brown false-membrane of sterile cells which disintegrate apically exposing a semi-powdery spore-mass surrounding a simple columella; sterile cells chiefly in twos, about the same size as the spores, tinted yellowish-brown; spores subglobose to broadly ellipsoidal or sometimes triangular, irregular and frequently angular, olivaceous-brown, chiefly 10.5 to 14 μ long, apparently smooth but very minutely echinulate under the oil immersion.

Soris in ovariis oblongatis ca. 1–1.5 cm. plus minusve longis, 1 mm. latis, falsa membrana atro-brunnea tectis ex cellulis sterilibus in apice dissolventibus et massam sporarum semi-pulverulentam exponentibus simplici columellae circumstantem; cellulis sterilibus plerumque binis eandem fere magnitudinem ac sporae habentibus, subflavo-brunneis; sporis subglobosis vel late ellipsoideis vel interdum triangularibus, irregularibus et saepe angularibus, olivaceo-brunneis, plerumque 10.5–14 μ longis, apparenter levibus sed minute echinulatis sub oleo ut dicunt immersis.
Hab. in *Themeda triandra* Forsk., etc.

On *Themeda triandra* Forsk., Benguet subprovince, Luzon, Philippine Islands. Coll. E. D. Merrill, May 1911. Flora of the Philippine Islands No. *7908*.

The specimen used for the above description was borrowed from the Bureau of Science, Manilla, P. I. It was labeled *Ustilago bursa* Berk., Det. Sydow. Upon request Dr. G. C. Ainsworth of the Imperial Mycological Institute, Kew has kindly furnished the writer a description and a good drawing of *Ustilago bursa* based on an examination of the type specimen at Kew Gardens. It was found that the Philippine Island specimen did not agree with the

description of *U. bursa* and it is therefore described as a new species.

TWO NEW RECENTLY DESCRIBED GENERA

Recently two new genera of the Ustilaginales have been described in rather inaccessible publications. Therefore, the original descriptions are included in this paper, together with the original illustrations, in order to make them accessible to more workers.

In 1939, Kochman of Poland succeeded in germinating the spores of *Thecaphora leptideum* (Sydow) Zundel and found that the promycelium and sporidia were of a type hitherto undescribed. Based on the type of germination he proposed a new genus of the family Tilletiaceae with the following descriptions:

GLOMOSPORIUM J. Kochman, Acta Soc. Bot. Poloniae **16**: 57–58. 1939. Ill.

Sporae in glomerulos rotundatos conglobatae, promycelium unicellulare, sporidia elliptica, subarcuata, terminalia 3–4 gerens.

GLOMOSPORIUM LEPTIDEUM (Syd.) Kochman. *Tolyposporium leptideum* Syd., Ann. Myc. **11**: 365. 1913. *Thecaphora leptideum* Zundel, Mycologia **29**: 583. 1937.

Diagnosis fructificationis et sporarum cf. Sydow l. c. sed glomeruli maiores: 33–65 μ diam. et usque 95 μ longi.

Germinatio e promycelio unicellulari 12.5–15 μ crasso et circa 40 μ longo. Sporidia terminalia, elliptica, attenuata, subarcuata 4.5 μ crass. et 12.5 μ long., utrinque 11–12 spiculis longis praedita.

Hab. in ovaries of *Chenopodium album*, France, Germany, Poland, Hungary, Czechoslovakia, Latvia. *Chenopodium striatum* × *opulifolium*, France. *Chenopodium ambrosioides*, Australia.

In 1936 N. N. Lavrov of the University of Tomsk, Siberia, U. S. S. R., described a new genus of the family Ustilagineae and named it *Tranzschiella* in honor of the veteran Russian mycologist W. H. Tranzschel. This genus must not be confused with the rust genus *Tranzschelia* Arthur. Through the courtesy of the Imperial Mycological Institute, Kew, Surrey the original description and illustrations have been secured.

TRANZSCHIELLA Lavrov, Travaux de l'Institut Scientifique de Biologie d'Universite de Tomsk **2**: 29. 1936.

Characteres fere Ustilaginis. Chlamydosporis opposite vel ad angulis cellulis arcte adnatis pusillis auctis; promycelio (phragmobasidia) in aqua pluvia nato hyalino, filiformi, septato; ramulis filiformibus in sporidiolam comminutis; sporidiolis elongatis, subhyalinis, levibus.

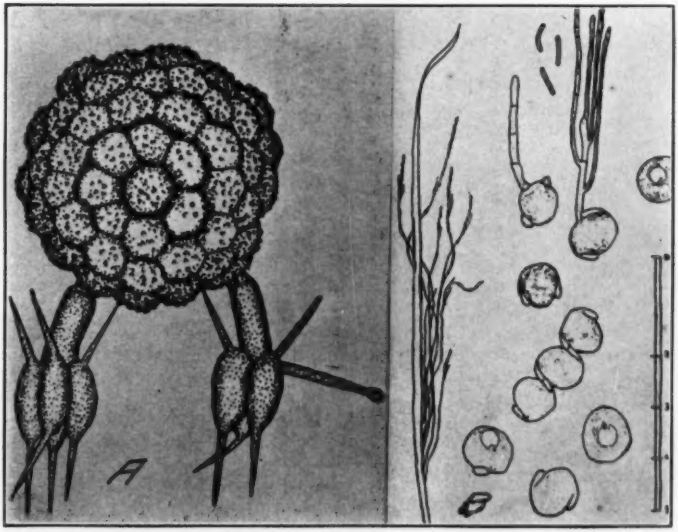

FIG. 3. *A, Glomosporium leptideum Kochman.* Germinating chlamydospore. After the original. Photo by Hill & Grove. *B, Tranzschiella otophora* Lavrov. After the original. Photo by Kribs.

TRANZSCHIELLA OTOPHORA Lavrov, Trav. Inst. Sci. Biol. Univ. Tomsk **2**: 29. 1936.

Sporis primo compactiusculis, tunica candida vestitis, dein erumpentibus, pulverulentis, atro-olivaceis, in culmis, glumellis, ovariis incolentibus; sporis 6–10 micr. diam. obscure-brunneis vel brunneo-olivaceis subglobosis, ellipsoideis vel rotundato-angulatis, sublevibus, 0.45–0.6 micr. cras. tunicatis, opposite vel ad angulos cellulis arcte adnatis pusillis hyalinis, 3–4 micr. long. 1–2 micr. crass. auctis; promycelio (phragmo-basidia), in aqua pluvia nato, hyalino, filiformi, 4-cellulari, 20–25 × 2–2.5 micr.; ramulis filiformibus, polycellularibus, 40–70 × 1.25–0.85 micr. in sporidiolam oidiiforme comminutis; sporidiolis elongatis 6–4 × 1.25–0.85 micr., subhyalinis, levibus.

Habitat in parte superiore caulis, in ovariis glumellisque *Stipae pennatae* L. (typice), nec non *Stipae barbatae* Desf., *Stipae Lessingianae* Triu, et Rupr., *Stipae capillatae* L. in Steppis Sibiriae orientalis occidentalisque, Asiae centralis et Tauriae.

Species haec nostra *Tranzschiellae appendiculatae* (Speg.) Lavr. comb. nov. (Syn. *Ustilago? appendiculata* Speg. 1909) proxima, sed area geographica et dimensione sporarum paulum diversa.

NOTES ON THE POTATO SMUT

POLYSACCOPSIS HIERONYMI (Schröt.) P. Henn., Hedwigia Beib. **37**: 206. 1898.

Syn. *Urocystis Hieronymi* Schröt., Hedwigia **35**: 218. 1896.

This potato smut attacking species of *Solanum* in various parts of South America seems to be rather rare so far as can be judged from available records. Large galls develop on the stems, berries, and leaves and it was first described by Schröter as a *Urocystis* as follows:

"Soris in ramulis vel pedunculis, et bullam curvatam, c. 3 cm. longam, 1½ cm. crassam efformantibus, cuticula c. 1 mm. crassa, ochraceo, rugulosa tectis; glomerulis ellipsoideis, 22–40 × 22–30 μ; sporis centralibus singularibus, globosis vel ellipsoideis, 16–26 × 15–20, episporis, castaneo, levi; sporis peripheric is 7–12 × 6–8 μ, pollide brunneis. Bolivia auf der Cuesta Zwischen Santa Rosa und Carapari in Stielen von Solanum sp. 17–18 June 1873. G. Hieronymus u. P. G. Lorentz."

From an examination of available material the following description has been written:

POLYSACCOPSIS HIERONYMI (Schröt.) P. Henn.

Sori as large irregular gall-like swellings on the stems, young branches and in the leaves, 3–5 cm. long, 1.5–2.5 cm. wide, covered by a thick yellowish membrane which soon ruptures exposing a granular spore mass which is produced in numerous sac-like cavities formed by the mycelium; spore balls globose to ellipsoidal or angular, often irregular in shape, chiefly composed of one central fertile spore and a continuous layer of sterile peripheral cells; chiefly 28–41 μ diameter; spores globose to ellipsoidal or irregular, chestnut brown, chiefly 22–26 μ long, smooth; sterile cells globose to ellipsoidal, firmly pressed together, forming a continuous layer around the central spore, tinted brown to almost hyaline, chiefly 9–13 μ long, smooth.

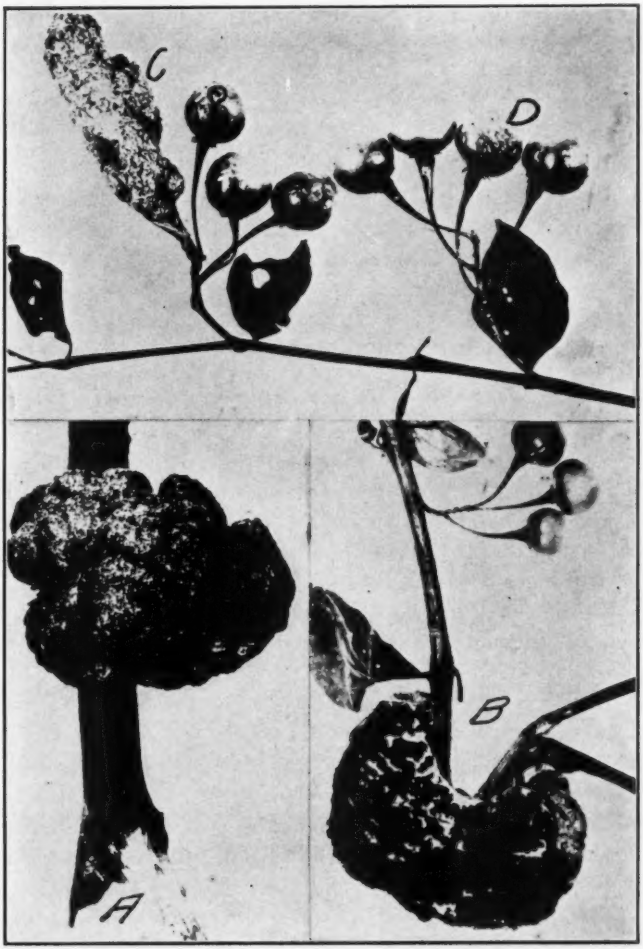

FIG. 4. *Polysaccopsis Hieronymi* (Schröt.) P. Henn. on *Solanum* sp. Brazil. *A, C, D,* sori on the stems, leaves and berries; *B,* cross section of a sorus on a stem showing the small cavities full of spores. Photo by Viegas.

On *Solanum* sp.: Argentina, Bolivia, Brazil.

The illustrations of the potato smut were kindly furnished by Prof. A. P. Viégas, Instituto Agronomico do Estado de São Paulo, Campinas, Brazil.

NOTES CONCERNING THE GENUS MELANOPSICHIUM

In 1881 Spegazzini described from Argentine Republic a new species of the Ustilaginales on *Polygonum acre* L. to which he gave the name *Ustilago austro-americana* (Anal. Soc. Ci. Agrent. **12**: 63. 1881) together with the following description—

"Soris hypodermici primo bulloso-prominuli, suborbiculares, parvuli (0.2–0.5 diam.) saepius confluentes, matricem irregulariter contorto turnefactam efficientes, dein erumpentes, udi difluenti—visciduli, sicci compacti, tenaces, duri, aterrimi, opaci; sporae globosae, v. irregulariter ovato-ellipticae, episporio crassiusculo levissimo, amoene fuligineo—sub—violaceae (10–14 ×8–11), strato mucoso obovolutae!"

About this time a similar smut on *Polygonum* sp. was found in the Mississippi valley which was considered to be the same species as the one described by Spegazzini. In 1881, Seymour collected this smut in Illinois. Burrill studied it and gave it an unpublished herbarium name viz. "*Ustilago notabilis* Burrill, on *Polygonum pennsylvanicum*, Bluff Lake, Union Co. Oct. 26, 1881, Coll. A. B. Seymour—Illinois Fungi, Herb. State Laboratory of Natural History No. *2012*." This is a true *Melanopsichium pennsylvanicum* as described later. It was later collected by Rev. C. H. Demetrio at Perryville, Missouri, September 1885, and issued in exsiccati as Rab.-Winter, Fungi Eur. *3501* with the following information, "Rabenhorst-Winter, Fungi europaei, *3501*. *Ustilago austro-americana* Spegazzini, Fungi Argentini IV, Pug. 19, America borealis: prope Perryville, Missouri. In foliis, petiolis, praecipuc autem ad perigonia *Polygonii incarnati* L., September 1885. leg. C. H. Demetrio. Obs. Es wäre sehr zu wunschen, dass diese ausserst interessante Art, die wohl kaum zu *Ustilago* gehört, einer eingehenden Untersuchung unterworfen wurde, wozu nur leider die seit mangelt. G. W." It is to be noted that George Winter doubted that this species belonged to the genus *Ustilago*. Nine years later G. Beck studied the above mentioned exsiccati specimen and decided that it belonged to an undescribed genus to which

he gave the name *Melanopsichium* (Ann. Natur. Hofmus. Wien **9**: 122. 1894) using the specimen collected at Perryville, Missouri by Demetrio as the type.

That the above mentioned specimen was wrongly named was realized by Ellis. In the Ellis collection now in the New York Botanical Garden is deposited an unpublished description, apparently in the handwriting of Ellis, of a *Polygonum* smut collected by B. T. Galloway, 1885 in Boone Co. Missouri, and to which the herbarium name of *Ustilago indurata* E. & E. is given. The note is as follows:

"*Ustilago indurata* E. & E.

On *Polygonum* sp. Boone Co., Mo.—leg. B. T. Galloway.

In the spikes of the inflorescence, forming irregular tubercular masses ½–1 cm. diam. at intervals along the spike which at these points is entirely enveloped and transformed into a violet-black, cavernous mass of spores which seem as if glued together, having a hard solid texture something like the stick liquorice of the shops only more brittle, almost carbonaceous. Spores subhyaline at first and small (4–6 μ), becoming dark and either globose, 8–12 μ diam. or subelongated, 14–18 $\times$ 7–10 μ, surface deeply tuberculose-reticulated.

Ustilago austro-americana Speg. has a similar habitat but the spores are *smooth*. Dr. Farlow in Bot. Gaz. VIII, p. 278 doubtfully refers specimens collected in Iowa by Prof. C. E. Bessey, on *Polygonum* (*Pennsylvanicum*) and apparently the same as the Missouri specimens to *U. Bistortarum* D. C. but as far as we can judge from the specimens of that species in Rabh. F. Eur. *2602* and in Kunze's Fungi Selecti nos. *530* & *504*, the form above described should be specifically distinct. Specimens of *U. Bistortarum* on *Polygonum Bistorta* from the Pacific coast agree perfectly with the European specimens, the mass of spores being not at all indurated but loose and dusty and the spores themselves are merely papillose."

It is thus to be seen that Ellis did not consider the smut described by Spegazzini as the same one found in the Mississippi valley. He noted the smooth spores of the Spegazzini smut and

the echinulate spores of the smut collected by Demetrio and Galloway.

G. P. Clinton published the first monograph of the "North American Ustilagineae" in 1904 as a doctorate thesis at Harvard University. He used the name *Melanopsichium austro-americanum* (Speg.) Beck for the North American Smut, basing his conclusion that the *Polygonum* smut in question was the same as the Argentina smut from information received from Spegazzini. In his thesis (Proc. Boston Soc. Nat. Hist. **31**: 397. 1904) he adds the following note "This was first described from South America where it apparently grows more commonly on the leaves than it does here. The writer has not seen specimens from there but sent a specimen to Spegazzini who pronounced it the same as his species. In this country the smut appears to be most common in the Mississippi valley. It has a number of characters, *e.g.*, the hygrophilous manner of shedding its spores and the gelatinous spore envelop that relates it to *Cintractia externa*. The germination has been reported by Norton. (Trans. Acad. Sci. St. Louis, **7**: 229–241. 1896. Illustr.)"

It is difficult to understand how such an error on the part of Spegazzini and Clinton could have been made since Spegazzini originally described the spores of *Ustilago austro-americana* as being smooth while in all of the publications of Clinton he describes the spores of the supposedly same smut in North America as echinulate. This error has recently been corrected by Elisa Hirschhorn (Nota d. Museo de La Plata (Bot. 32.) **6**: 147–151. 1941 Ill.) and two species are recognized. Basing her conclusion from examination of two specimens, from the United States, *e.g.*, Phillipsburg, Kansas, 8/1910, leg. Bartholomew, on *Polygonum pennsylvanicum* and ex. herb. Clinton, 9/1892, Urbana, Illinois on *Polygonum lapathifolium* she names the echinulate spored species, *Melanopsichium pennsylvanicum* Hirschh. with the following description: "Sporis aurantiacis, globosis vel irregulariter, ovato-ellipticis; episporio spinoso; diam. 7–11 μ vel 11–10 $\times$ 6–7 μ."

In order to definitely determine if both species exist in North America the writer obtained on loan all specimens labeled *Melanopsichium austro-americanum* (Speg.) Beck, from the Missouri Botanical Garden, Farlow Herbarium, Harvard University, The

New York Botanical Garden, Stanford University, the U. S. Department of Agriculture, Mycological Collections, and the University of California, and this courtesy is acknowledged with thanks. In all, 65 specimens were examined but in several cases duplicates of a given collection were found to be deposited in two or more herbaria. In such cases the duplicate specimens were examined separately and at a different time. It was found (1) that all collections made from Wyoming east to the Atlantic Coast had echinulate spores (2) collections made in California and some in Texas had smooth spores. (3) Available collections from China had finely echinulate spores when under oil immersion, but exsiccati specimens from India had smooth spores. It was further noted that where the host was *Polygonum pennsylvanicum* the spores were globose to subglobose, chiefly 7–10.5 μ diameter. Where the host was *Polygonum lapathifolium* there were two types of spores (1) globose to elongate, often irregular, chiefly 10.5–14 μ long, and (2) globose to subglobose, 7–10.5 μ diameter as given for *P. pennsylvanicum*. All echinuate spores were olivaceous-brown in color but the smooth spores were usually light olivaceous-brown to subhyaline. On the basis of spore measurements it is proposed to divide *Melanopsichium pennsylvanicum* Hirschh. into a typical species and two varieties as follows:

1. MELANOPSICHIUM PENNSYLVANICUM Hirschh.

Sori as previously described; spores globose to subglobose, olivaceous-brown, chiefly 7–10.5 diameter, echinulate.

On *Polygonum Hydropiper* L.: Illinois.

On *Polygonum lapathifolium* L. (*P. incarnatum* Ellis): District of Columbia, Illinois, Iowa, New York, Missouri.

On *Polygonum pennsylvanicum* L.: Illinois, Indiana, Kansas, Missouri, New Jersey, New York.

On *Polygonum* sp.: District of Columbia, Texas, China.

On *Polygonum virginianum* (L.) Raf.: Missouri.

2. MELANOPSICHIUM PENNSYLVANICUM Hirschh. var. **Besseyanum** Zundel, var. nov.

Sori as previously described; spores globose to elongate-ellipsoidal, olivaceous-brown, chiefly 10.5–14 μ long, echinulate.

On *Polygonum* sp., Ames, Iowa. Coll. C. E. Bessey, 1878. Ex. Herb. C. E. Bessey (Type).

On *Polygonum Hydropiper* L.: District of Columbia.

On *Polygonum lapathifolium* L. (*P. incarnatum* Ellis): Illinois, Missouri, New York, Wyoming.

An unusual specimen collected at Congers, New York seems to be a second variety. The difference consists in the large pustular sori that develop on the stems instead of in the inflorescence. The following name is proposed and described:

3. MELANOPSICHIUM PENNSYLVANICUM var. **caulicola** Zundel, var. nov.

Sori as large, hard, dark pustules on the stem, 2–3 cm. long, 1–1.5 cm. wide, otherwise as for the species; spores globose to subglobose, chiefly regular, chiefly 7–10.5 μ diameter, rarely 14 μ light olivaceous-brown to subhyaline, echinulate.

On *Polygonum lapathifolium* L. Congers, Rockland Co., New York. Coll. A. David Davies, Oct. 25, 1934 (Cornell Univ. Herb. *23993* also in Farlow Herbarium, Harvard University).

4. MELANOPSICHIUM AUSTRO-AMERICANUM Speg. is distributed as follows:

On *Polygonum aviculare* L.: California (Coll. H. W. Harkness, Herb. W. G. Farlow).

On *Polygonum glabrum* Willd.: India: Pusa (Syd. Fung. exot. *407, 497;* Syd. Ustil. *392*).

On *Polygonum lapathifolium* L.: California (Seal Beach, Calif., Sept. 16, 1936, Com. H. C. McMillan (No. *70914,* U. S. D. A. Myc. Coll. also N. Y. Bot. Gard.; Rio Hondo, Los Angeles Co., Oct. 14, 1832, alt. 190 ft., Herb. Louis C. Wheeler, Flora of California No. *1431*); Texas (F. Lindheimer Fasc. IV, 1847–8, Herb. W. G. Farlow).

A LEAF SPOT OF GRASSES CAUSED BY A NEW SPECIES OF PHLEOSPORA[1]

JOHN R. HARDISON AND RODERICK SPRAGUE[2]

(WITH 2 FIGURES)

During an investigation of the grass diseases occurring in Michigan in 1941, a leaf spot was collected on *Agropyron repens* (L.) Beauv. and *Elymus canadensis* L. caused by a fungus which was tentatively reported as *Phleospora* sp. (2). The infection on *Elymus canadensis* was very light and occurred only on the leaf blades. On *Agropyron repens* the infection was heavy on leaf blades (FIG. 1) and extended to the leaf sheaths in some instances. The causal fungus is described as follows:

Phleospora graminearum Sprague & Hardison, sp. nov.

Maculae variabiles, elongatae, brunneae, centro pallidae, margine luteae vel ochraceae. Pycnidia subgregaria, primum immersa, absque ostiolis, brunnea, demum erumpentia, prominentia, ostiolo parvo singulo praedita, subglobosa, diam. maturitate 90–160 μ, superficiei delapsu translucentia, aureilutea; pycnophoris obtusis, brevibus, 3–5 μ latis, hyalinis; pycnosporis obclavatis, chlorinihyalinis apice obtusis, basi rotundatis vel obtusis, variabilibus, 30–55 μ longis, 3.3–5.6 μ latis, 1–6-septatis.

In foliis vivis *Elymi canadensis* et *Agropyri repentis*. Specimen typicum legit J. R. Hardison (41–81) in foliis *Agropyri* prope urbem Ann Arbor, Michigan, Sept. 1941.

Spots variable, elongate, brown, paler in center, margins sometimes yellow or buff colored. Pycnidia subgregarious, at first immersed, non-ostiolate, brown, later erumpent, prominent, with small

[1] Coöperative investigation between the Department of Botany and University Herbarium, University of Michigan and the Divisions of Forage Crops & Diseases and Cereal Crops & Diseases, Bureau of Plant Industry, U. S. Department of Agriculture.

[2] Formerly Research Assistant, Department of Botany, University of Michigan and Pathologist, Division of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, respectively. The writers are indebted to Prof. H. H. Bartlett, Department of Botany, University of Michigan for assistance in preparing the Latin description.

ostiole, subglobose, 90–160 μ, pale brown, upper layer finally breaking away, context translucent and golden colored; pycnophores blunt, short, 3–5 μ wide, hyaline, pycnospores yellow-hyaline obclavate, tapering to a blunt point, base rounded or blunt, variable, 30–55 $\times$ 3.3–5.6 μ, 1- to 6-septate.

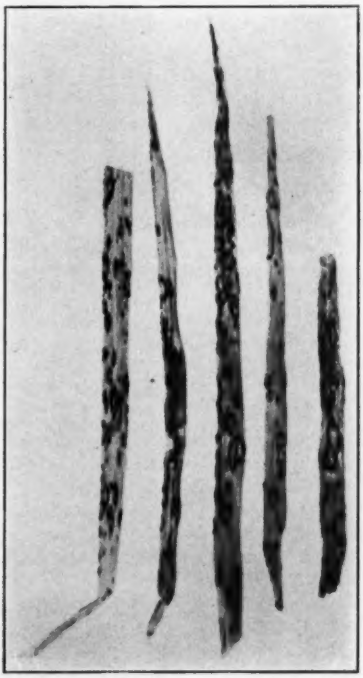

FIG. 1. Habit of *Phleospora graminearum* on *Agropyron repens* from the type collection, $\times$ 1½. Photograph by George W. Fisher.

In living leaves of *Elymus canadensis* and *Agropyron repens*. Type specimen in leaves of *Agropyron repens*, Ann Arbor, Michigan, Sept. 1941, John R. Hardison.

Type material has been deposited in the Mycological Collections of the Bureau of Plant Industry, Washington, D. C. (B.P.I. *80,402*) and in the University Herbarium, of the University of Michigan.

In the course of completed but unpublished studies of *Septoria* (**3**, **6**), *Stagnospora* (**6**), *Phaeoseptoria* (**4**), *Hendersonia* (**7**) and *Ascochyta* (**5**) on Gramineae one of the writers (Sprague) had not seen any fungi on Gramineae,[3] referable to *Phleospora* Wallr. However, this fungus, which is quite distinct from any other sphaeropsidaceous fungus seen on Gramineae, is readily referable to that genus. Grove's discussion of *Phleospora* (**1**) summarizes the popular concept. It is a genus having pycnidia with relatively

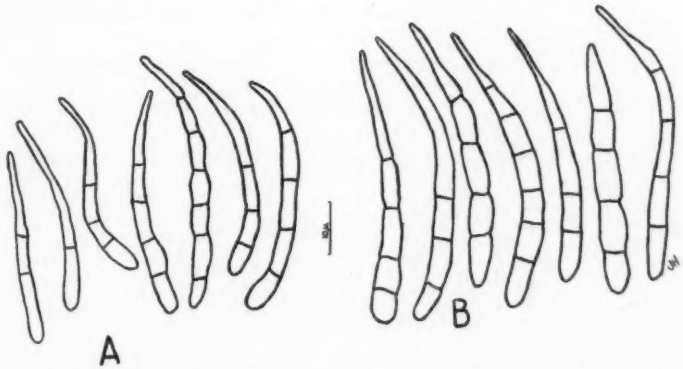

FIG. 2. *A*, pycnospores of *Phleospora graminearum* from the type collection on *Agropyron repens; B*, pycnospores of *Phleospora graminearum* on *Elymus canadensis.*

thin apices, which soon burst or evanesce to release a mass of comparatively coarse spores, such as characterize the present fungus (FIG. 2). Diedicke rejected *Phleospora*, placing some of the fungi in *Septoria* and the rest in *Cylindrosporium*. On this basis our specimens would belong in *Septoria*. However, their coarse, broad spores borne in poorly developed pycnidia are atypical for *Septoria* and the obclavate shape of the spores is, incidentally, atypical for *Stagonospora*. The spores are too pale for *Phaeoseptoria*.

Since there appears to be some justification for the genus *Phleospora* and since this fungus definitely answers its require-

[3] These several manuscripts have been or are being submitted for publication but under present conditions will be long delayed in publication. Reference is made to them to indicate a background for study of the *Phleospora* species discussed in the present note.

ments more than that of any other genus, we have referred these collections accordingly.

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ASSOCIATION OF THRIPS WITH POWDERY MILDEWS

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On July 3, 1942, it was observed that mildewed leaves of Carignane grapes growing in an experimental field plot at Albany, California, were frequently infested with thrips while mildew-free leaves usually showed no thrips. On lightly mildewed leaves any thrips present were usually on the mildew colonies. Lightly mildewed leaves usually had fewer thrips than heavily mildewed leaves, but leaves on which the mildew mycelium was dead usually bore no thrips. The thrips were usually on the lower (dorsal) leaf surface. Several field counts of thrips were therefore made with results as follows:

Date, location, fungus and host	Number of leaves examined	Average number of thrips per leaf	
		Healthy leaves	Mildewed leaves
July 3, Albany, *Uncinula necator* on grape	28	0.15	4.0
Aug. 13, Albany, *Uncinula necator* on grape	25	0.25	0.95
Aug. 17, Santa Rosa, *Uncinula necator* on grape	48	0.0	0.04
Aug. 30, Fairfax, *Uncinula necator* on grape	6	0.0	0.25
Sept. 2, Albany, *Uncinula necator* on grape	10	0.0	2.0
Sept. 2, Santa Clara, *Uncinula necator* on grape	14	1.0	0.8
Sept. 5, San Pablo, *Uncinula necator* on grape	4	0.0	0.5
Sept. 19, Albany, *Sphaerotheca pannosa* on rose	49	0.08	0.8
Sept. 19, Albany, *Sphaerotheca humuli* on strawberry	19	0.11	2.4
Sept. 19, Albany, *Erysiphe Cichoracearum* on cantaloupe	11	—	1.2

In addition, thrips were observed in association with powdery mildew of clover, *Erysiphe Polygoni,* and powdery mildew of *Oenothera, Erysiphe Polygoni,* near Wright's Lake, El Dorado County, on October 4, 1942, though no counts were made. However, field observations in 3 locations of unidentified grape varieties with hairy lower leaf surfaces revealed no thrips on healthy or mildewed leaves.

While most observations were made at Albany and most thrips were collected there, the association of thrips with powdery mildews in other localities indicates that the phenomenon may be of widespread occurrence. As observed in the field the mildew appeared normal to the unaided eye, and no controlling effect of the thrips on the powdery mildew as a plant disease was apparent. Nor was the powdery mildew apparently responsible for an economically important occurrence of thrips or thrips injury.

Thrips from the Carignane grapes at Albany were identified as *Thrips tabaci* Lind. by Dr. Stanley Bailey of the Division of Entomology. Other collections of thrips in association with powdery mildews on other hosts appeared to be similar in general appearance. This species is known to be rather omnivorous in its feeding habits. Larvae and adults were present on the mildewed leaves.

Mildewed grape and rose leaves bearing thrips were brought to the laboratory and placed on 10 per cent sucrose solution in petri dishes. Many thrips disappeared from such cultures but some remained active for as long as 8 days. New thrips larvae also appeared on these leaves, presumably from eggs which had hatched after the leaves were brought in. The feeding of the thrips on the mildewed leaves was observed by means of dark field illumination at a magnification of 200 diameters. Actual ingestion of fungus material was not determined but after a thrips moved over a mildewed area, mechanical damage to prostrate hyphae was observed and the motion of the insect's head indicated that it was actively feeding on the fungus.

The mildew on detached rose leaves bearing no thrips and to a lesser extent on grape leaves, developed luxuriantly in the dish cultures and produced an abundance of conidia, but mildew colonies on leaves bearing thrips developed poorly, and if the number of thrips was sufficient the mildew was killed, as judged by the absence of turgid mycelium. In one case one thrips apparently killed one rose mildew colony of about 6 mm. diameter in 3 days. In no case was all the mildew mycelium devoured by the thrips, and this would hardly be expected from an insect with rasping and sucking mouth parts. Some of the damage to the mildew colonies may have been due to the secretions of the insect and to injury caused by the insect walking through the colonies.

To further determine by cultural means the nature of the association between thrips and mildew, thrips from mildewed leaves of grape and rose were transferred to thrips-free healthy and mildewed leaves of grape, rose, bean, and cucumber. The thrips tended to remain associated with the mildewed leaves to a greater extent than with the healthy. In one test 16 thrips were transferred with a brush from mildewed grape leaves to mildew-free rose leaves in petri dishes on 10 per cent sucrose and 16 were transferred to mildewed leaves of approximately the same age in another set of dishes. Three days later only one thrips was found on the healthy leaves while there were 5 on the mildewed leaves. In another test of the same type 7 out of 14 transferred thrips were found on healthy rose leaves after 3 days and 25 out of 25 transferred thrips were found on mildewed leaves. In a third test healthy and mildewed rose leaves were placed in contact with each other in the same dishes. Eight thrips were transferred to healthy leaves and 10 to mildewed leaves. Three days later there were 2 thrips on the healthy and 16 on the mildewed leaves.

Thrips transferred from field grape leaves to healthy or mildewed rose leaves in petri dishes seemed to thrive as well as thrips from rose leaves transferred to rose, but in one test thrips from grape did not remain in such large numbers on healthy and mildewed leaves of bean and cucumber in dish cultures, as on grape and rose leaves.

SUMMARY

Thrips tabaci has been observed associated with powdery mildew infections on grape, rose, strawberry, cantalope, clover, and *Oenothera*. In dish cultures thrips transferred to mildewed leaves of grape and rose thrived better than those transferred to healthy leaves. The thrips appeared to feed on and destroy established mildew colonies on rose and grape leaves, but were present in such small numbers under field conditions as to be of no apparent economic importance.

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THE EFFECTS OF CERTAIN SUGARS AND AMINO ACIDS UPON THE RESPIRATION OF ALLOMYCES [1, 2]

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Studies involving the nutritional requirements of aquatic fungi, based on growth experiments, have been carried out with numerous representative species (Volkonsky, **1932–33**; Stüben, **1939**; Schade, **1940**; Moreau & Moreau, **1940**; Emerson, **1941**). Only a few workers, however, have made use of respirometer techniques for testing the respiration of a particular pure substrate as determined by an effect on the oxygen consumption.

In the case of *Leptomitus lacteus*, studied by Schade and Thimann (**1940**), l-leucine and d, l-alanine were found to support growth of this fungus and to cause an increase oxygen consumption by the mycelia as determined by use of Warburg respirometers. Although these amino acids were apparently both respired and utilized in growth by *L. lacteus*, evidence has accumulated that some organisms may respire nutrient substances and yet be unable to employ them in growth (Tamiya, **1932**). Furthermore, it is possible that after continued contact with originally unassimilable or inactive nutrient materials, alteration in metabolism may occur through adaptive enzyme action such as that described for yeast and bacteria by Karström (**1930**), Stephenson and Yudkin (**1936**) and Stephenson and Gale (**1937**). The present study is concerned only with the immediate or initial effect of a particular sugar or amino acid upon the oxygen consumption of *Allomyces*. The time during which the cells are in contact with the nutrient materials is insufficient for cell multiplication and adaptation by natural selec-

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[2] Supported in part by a grant-in-aid for technical assistance from the Graduate School, Vanderbilt University, and a grant for apparatus from the Penrose Fund of the American Philosophical Society.

tion or adaptation induced by the chemical environment. The effects shown should therefore depend upon the nature of the constitutive enzymes of each species studied. Although the question as to whether the substrate is actually utilized in growth cannot be settled by respirometer experiments of short duration, the substrates which stimulate metabolism of starved mycelia should be strongly suspected of supporting growth, a point to be determined through additional investigation.

Allomyces is a genus of phycomycetous fungi belonging to the Order Blastocladiales. Its members are typically aquatic although they are also well known from terrestrial habitats. At least four well-defined species of *Allomyces* are recognized in recent taxonomic accounts of the genus (Indoh, **1940**; Wolf, **1941**; Emerson, **1941**). *A. arbuscula* and *A. javanicus* (belonging to the subgenus *Euallomyces* of Emerson) are long-cycled forms with a life cycle characterized by the alteration of an asexual and a sexual generation. *A. moniliformis* and *A. cystogenus* (belonging to the subgenus *Cystogenes*) are species which have a life cycle consisting of but one obvious generation and involving the formation of cysts (McCranie, **1942**). Thus, fundamental differences in the life cycle exist within the genus.

MATERIALS AND METHODS. One strain of each of these four species, identified as follows, was studied comparatively:

1. *A. arbuscula* Butler (**1911**) em. Hatch (**1933**). The strain used was the isolate "Cuba 2," which has previously been described by Wolf (**1940**).
2. *A. javanicus* Kniep (**1929**). The strain used was the isolate "Florida 2" (Wolf & Wolf, **1941**). This isolate has elongate female gametangia, and is of the type called *A. javanicus* var. *macrogynus* by Emerson (**1941**).
3. *A. moniliformis* Coker & Braxton (**1926**) em. Emerson (**1938**). The strain used was the isolate "Cuba 4" previously described (Wolf, **1940**).
4. *A. cystogenus* Emerson (**1941**). The strain used was Dr. J. V. Harvey's isolate 2261, designated "Arizona 1" in the taxonomic account of Wolf (**1941**). This species is called *A. neo-moniliformis* by Indoh (**1940**).

Stock cultures of the fungi were maintained on boiled hemp seeds, in Petri dishes containing distilled water. A period of about a week from the time of inoculation was sufficient for growth of vigorous and well-developed colonies on this substrate. Only asexual cultures bearing thin-walled and resistant sporangia were used in these experiments; no studies were made of cultures of *A. arbuscula* and *A. javanicus* bearing gametangia.

The experimental procedures were carried out with respirometers of the differential volumeter type developed by Fenn (**1927**) from the original micro-respirometer of Thunberg (**1905**). The instruments used, previously found suitable for measurement of oxygen consumption by bacteria (Shoup, **1929**; Shoup & Kimler, **1934**), consisted of identical glass vessels of 15 ml. capacity connected by means of calibrated capillary tubing in such a manner that when shut off from the atmosphere by stopcocks, a closed system was formed. KOH-wells for absorption of the carbon dioxide produced were sealed within each vessel. Mycelia suspended in a non-nutrient buffer (Sørensen's phosphate) were placed in the experimental vessel with buffer alone being present in equal amount in the control vessel. Consumption of oxygen by the mycelia resulted in the movement of an index droplet of kerosene in the capillary toward the experimental vessel, the rate of movement being taken as a measure of the oxygen consumption. The apparatus was immersed in a large water-bath, and shaken by a motor-driven eccentric. Experiments were performed at temperatures ranging from 15.0° C. to 28.0° C., but the temperature during the course of any single set of experiments of three hours duration remained constant within $\pm$ 0.1° C.

When ready for use the mycelia were separated from the hemp seed, washed thoroughly in distilled water and suspended in 1.8 cc. of M/20 Sørensen's phosphate buffer (pH 7.3) within the experimental vessels of the respirometers. Tests were made to determine if there was an effect on respiration rate when mycelia were removed from distilled water to buffer solution but no alteration in metabolism nor change in appearance in the mycelia was noted. Following equilibration for temperature in the water-bath, readings of the oxygen consumption were made at 5-minute intervals during a period of 40 minutes in order to determine the respiration rate

of the mycelia in the non-nutrient medium. At the expiration of this period, 0.2 cc. of M/10 solution of a particular carbohydrate or amino acid was introduced into both the control and experimental vessels. Then, with a final concentration of the nutrient material of M/100, a second oxygen consumption determination was made using the same mycelia during a similar 40-minute period. In the various experiments, the time elapsing between the end of a control run and the beginning of an experimental run ranged from 10 to 20 minutes.

An effect on respiration due to the substrate was indicated when the rate of oxygen consumption in the experimental run was greater than in the control run on the same mycelial mat. Preliminary trials, in which mycelia were removed from hemp seed and immediately used in such an experiment as described, indicated little or no increase in the respiratory rate over that of the control after addition of any of the respirable substances. This was interpreted to indicate the presence of stored food within the mycelia sufficient to enable metabolism to proceed at the maximal rate. It therefore appeared necessary to starve the mycelia, depleting the food reserves and lowering the respiratory rate, before performing the experiments. For the same reason a similar starvation procedure was used by Schade and Thimann (**1940**). After an experimental study of the time factor involved in such starvation, it was decided to perform all experiments with mycelial removed from hemp seed and placed in distilled water alone for approximately 7 (*i.e.*, 6–8) days prior to use in a respiration experiment. Transfer of the mycelia from distilled water to non-nutrient buffer solution again had no apparent effect on respiration capacity nor did it cause injury from differences in osmotic values.

Approximately 150 experiments of the type described were performed in the course of this study. These experiments have involved examination of 22 different substrates of suspected physiological importance. Reagents used were analytical grade C.P. chemicals in all cases, from Eastman, Pfanstiehl, or Merck, and were of the highest purity obtainable.

The effect of each substrate was determined upon each of the four species of *Allomyces*. Duplicate confirming determinations for each substrate and each species were made in all cases. The

pH of the mycelial suspensions was determined with the glass electrode and potentiometer following the experiments and indicated no change in hydrogen-ion concentration had occurred. The results, as presented in the accompanying tabulation (TABLE 1) thus represent averages of at least two determinations, and are expressed as percentage of increase in rate of oxygen consumption in the presence of a given substrate, in comparison with the rate of oxygen consumption by the identical mycelia when in non-nutrient buffer.

TABLE 1

THE EFFECT OF VARIOUS CARBOHYDRATES AND AMINO ACIDS ON THE OXYGEN CONSUMPTION OF FOUR SPECIES OF *Allomyces*

Results are expressed as percentage of increase over the controls.

Substrate	*A. arbuscula*	*A. javanicus*	*A. moniliformis*	*A. cystogenus*
Mannitol	0	0	0	0
d-Arabinose	0	0	0	0
l-Arabinose	0	0	0	0
Glucose	0	0	0	0
Levulose	0	0	0	0
Galactose	0	0	0	0
Maltose	40	0	0	0
Lactose	0	0	0	0
Sucrose	40	0	0	0
Cellobiose	0	0	0	0
Dextrin [3]	75	45	100	100
Soluble Starch [3]	0	0	0	0
Peptone [4]	150	300	60	45
Glycine	0	0	0	0
Alanine	50	0	60	20
Leucine	105	0	0	0
Aspartic acid	15	25	120	100
Asparagin	80	0	0	0
Glutamic acid	55	100	170	60
Cystine	30	40	0	0
Arginine-HCl	160	45	0	0
Tyrosine	0	0	0	0

DISCUSSION. It may be recalled that but a single strain of each species has been studied, hence there exists the possibility that the results may be characteristic of these particular strains only, and not of the species in general. Nevertheless, certain conclusions seem warranted. It is evident first of all, from the results pre-

[3] The concentration used was M/100 on assumption that $n = 1$ in the formula $(C_6H_{10}O_5)_n$.

[4] The concentration used was 1 per cent.

sented in Table 1, that peptone, dextrin, aspartic acid, and glutamic acid are respired by all four strains of the species of *Allomyces* under consideration, whereas eleven of the substrates tested, namely; mannitol, d-arabinose, l-arabinose, glucose, levulose, galactose, lactose, cellobiose, soluble starch, glycine, and tyrosine are not respired by any species of *Allomyces,* under the experimental conditions employed. In general, therefore, all of the species appear capable of respiring a greater variety of amino acids than of sugars. It may be assumed therefore and appears probable that in nature proteins and their degradation products furnish the greater part of their food. Carbohydrates do not appear to be of outstanding significance in the respiration of these fungi.

The remaining substrates (maltose, sucrose, alanine, leucine, asparagin, cystine, and arginine-HCl) are respired by one or more of the species of *Allomyces,* but not by all. It is evident that the four species under consideration show differences in their respiratory capabilities. Emerson and Fox (**1940**) noted differences in growth of certain species on oatmeal agar and "Yp. Ss. agar" (powdered yeast extract, soluble starch and inorganic salts). From their results the inference may be drawn that differences in respiratory powers exist, a conclusion that finds support in the present experiments.

A. arbuscula is capable of respiring a greater variety of nutrient materials than does any one of the three other species. Eleven of the substrates tested (maltose, sucrose, dextrin, peptone, alanine, leucine, aspartic acid, asparagin, glutamic acid, cystine, and arginine-HCl) are respired by *A. arbuscula,* six by *A. javanicus,* and five by *A. moniliformis* and *A. cystogenus.*

It is perhaps significant in this connection that *A. arbuscula,* on the basis of existing evidence, appears to be by far the most common and widely distributed of these species. This conclusion follows from the isolation work of Emerson (**1941**). Of at least 149 isolates listed by him as belonging to these four species, 125, or 84 per cent of the total, is composed of *A. arbuscula.* Of 52 isolates belonging to these four species studied by Wolf (**1940, 1941, 1941a**), 42, or 81 per cent of the total is *A. arbuscula.* These lines of evidence lead to the conclusion that there is a direct relationship between the ability of this species to respire a wider

variety of materials, under laboratory conditions, and its greater abundance in nature. Conversely, the more specialized requirements of *A. javanicus, A. moniliformis,* and *A. cystogenus* may plausibly have operated as limiting factors in the less frequent occurrence (or at least less frequent collection) of these species in nature.

Of the six substances known to be respired by *A. javanicus* or to stimulate its metabolism, each is also active upon *A. arbuscula.* On this basis there would appear to be a considerable degree of physiological similarity between the two species. It is at least an interesting coincidence that *A. javanicus* and *A. arbuscula* also have similar life cycles involving an alternation of asexual and sexual generations.

A. moniliformis and *A. cystogenus* have each been shown to respire and perhaps to utilize five of the 22 substances tested. No substance respired by one is not also respired by the other, indicating that these two species could be regarded as physiologically similar. All of the substances, with the exception of alanine, respired by them are also respired by both *A. arbuscula* and *A. javanicus.* Inasmuch as *A. moniliformis* and *A. cystogenus* have identical life cycles involving but a single obvious generation with subsequent cyst formation, and differ from *Euallomyces* in this respect, the existing taxonomic arrangement of the genus finds some degree of substantiation on physiological grounds. It would thus appear that the two species groups have somewhat characteristic constitutive enzyme systems responsible for increased oxygen uptake in the presence of the various substances.

SUMMARY

This study involves the use of oxygen consumption measurements, made by means of the Fenn differential volumeter, to determine the ability of four species of *Allomyces* (*A. arbuscula, A. javanicus, A. moniliformis, A. cystogenus*) to respire certain nutrient substances. Twenty-two different carbohydrates and amino acids were employed with each species.

Peptone, dextrin, aspartic acid, and glutamic acid were respired by all four species of *Allomyces,* whereas mannitol, d-arabinose,

l-arabinose, glucose, levulose, galactose, lactore, soluble starch, cellobiose, glycine and tyrosine were not respired by any of the species.

Differential results were obtained in experiments with maltose, sucrose, alanine, leucine, asparagin, cystine, and arginine-HCl. *A. arbuscula* is capable of respiring eleven of the substrates tested, *A. javanicus* can respire six, and *A. moniliformis* and *A. cystogenus* can respire five each. In an interpretation of these findings an attempt is made to correlate the more common occurrence of *A. arbuscula* in nature with its lack of physiological specialization.

The morphological similarities between *A. arbuscula* and *A. javanicus,* and between *A. moniliformis* and *A. cystogenus* appear to be correlated with similarities in respiratory metabolism and in the nature of their constitutive enzyme systems.

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DASTURELLA—A NEW GENUS OF UREDINALES

B. B. Mundkur and K. F. Kheswalla

(with 5 figures)

Among some rusts received at the *Herbarium Cryptogamae Indiae Orientalis* (Imperial Pusa Herbarium) for determination were three collections which cannot be placed in any known genera of the Uredinales. The first two collections are on *Dendrocalamus strictus* Nees and the third on *Bambusa* sp. Pycnia and aecia are lacking but a few uredia and a relatively larger number of telia are present in all the collections. The pustules are at first subepidermal but they soon rupture the epidermis and lie exposed on the surface of the leaves.

The teliospores are 3- to 6-celled and are united into compact, sessile heads without cysts. The heads bear a superficial semblance to those of *Ravenelia* and *Nothoravenelia* but in the former genus the teliospores are one- or two-celled and the heads are borne on compound, hyaline pedicels. In *Nothoravenelia* the teliospores are two-celled and the heads are sessile but both in this genus and in *Ravenelia* the cysts form a prominent feature of the teliospore-heads. The rusts under study do not belong to either of the two genera.

The species on *Dendrocalamus strictus* agreed, however, with *Angiopsora divina,* which was established by Sydow for a rust on *Bambusa* sp. collected by R. N. Tandon at Majhgawan on January 5, 1935. A specimen of this rust was kindly made available by Dr. Tandon from his collection No. 188, a part of which was made the type of the new species by Sydow (**1936**). The identification of the host as *Bambusa* sp. seems to have been tentative. Dr. N. L. Bor, Forest Botanist, Dehra Dun, thought that the leaves may be of *Dendrocalamus* sp.

The genus *Angiopsora* was established by Mains (**1934**) to accommodate those rusts on grasses whose telia occur as crust-like

masses of cells entirely covered by the epidermis. The telia are arranged in vertical rows up to three to four cells thick in the centre of the sorus. The cells adhere laterally as firmly as vertically but they tend to separate if crushed under a cover glass, indicating that the telia consist of one-celled, catanulate, sessile teliospores.

The adherence of the teliospores into compact crust-like masses, the uniformly palisade-like arrangement of the telia, their being non-erumpent and covered by a persistent epidermis, and the catenulate arrangement of the teliospores, characterise the genus *Angiopsora*. The telia of the rusts on *Dendrocalamus strictus* and *Bambusa* sp. do not form crust-like masses or a palisade-like arrangement; they are erumpent in a very early stage of their growth and vestiges of the epidermal layer, lifted by the developing telial head which emerges as a single solid structure, can be seen surrounding the pustules. The teliospores are fascicled into a cushion-like head with a definite flabelliform shape. These characters preclude the inclusion of the species in that genus. Regarding the teliospores, they do not appear to be one-celled or catenulate. Efforts made to separate the telial columns into individual spores by crushing them have shown that they break above or below the septa and occasionally at the septa. This indicates that the teliospores may be continuous structures, each made up of 3 to 6 cells. They are sessile, arise below in a cellular sheet and thin-walled but the apical wall is very thick. This wall fuses with the similarly thickened apical walls of the other spores, which gives firmness and shape to the head. This rather thick apical wall is a very characteristic feature, which is absent in *Angiopsora*.

The rusts on *Dendrocalamus strictus* and *Bambusa* sp. differ, not only from *Angiopsora* but other known rust genera, sufficiently to warrant the erection of a separate genus for the reception of these species for which the following name, in honour of J. F. Dastur, a distinguished Indian mycologist, is proposed.

Dasturella gen. nov.

Pycnia aeciaque nobis ignota. Uredia primo subepidermalia, deinde erumpentia, paraphysata, sine peridiis; urediosporae apedicellatae. Telia sub-

epidermalia, erumpentia; teliosporae in magnis coloratis, sessilibus caputibus, sine cystidiis, dispositae, utrimque, 2-, 6-, raro 7-locellatae.

Species typica: *Dasturella divina* (Sydow) Mundkur & Kheswalla.

Pycnia and aecia unknown. Uredia minute, at first subepidermal, later erumpent, paraphysate, without peridia; urediospores sessile. Telia subepidermal, erumpent; teliospores fascicled into large, coloured, sessile heads without cysts, 3- to 6-, rarely 7-celled.

TYPE SPECIES: *Dasturella divina* (Sydow) Mundkur & Kheswalla.

Dasturella divina (Sydow) comb. nov.

Uredia hypophyllous, solitary or in small stripes, covered for some time by a raised epidermis, later erumpent, pulverulent, bright brown, surrounded by numerous inwardly curved paraphyses; paraphyses cylindrical to tubular, 45–76 × 8–11 μ, almost hyaline to very slightly yellow; urediospores sessile, almost globose to egg-shaped or ellipsoidal, 18–26 × 15–23, echinulate, wall up to 1.5 μ thick, with 3 to 4 rather indistinct equatorial germ pores. Telia hypophyllous, usually solitary, rarely two or three coalescing, surrounded by a yellowish brown discolouration; subepidermal, erumpent, without paraphyses or peridium; teliospores sessile, arising from a cellular sheet, 59–114 × 8–17 μ, side walls up to 1.0 μ thick, apical wall 3.7 to 11.7 μ in thickness, dark cinnamon brown, 3- to 6-, rarely 7-celled. Germ pores obscure or none.

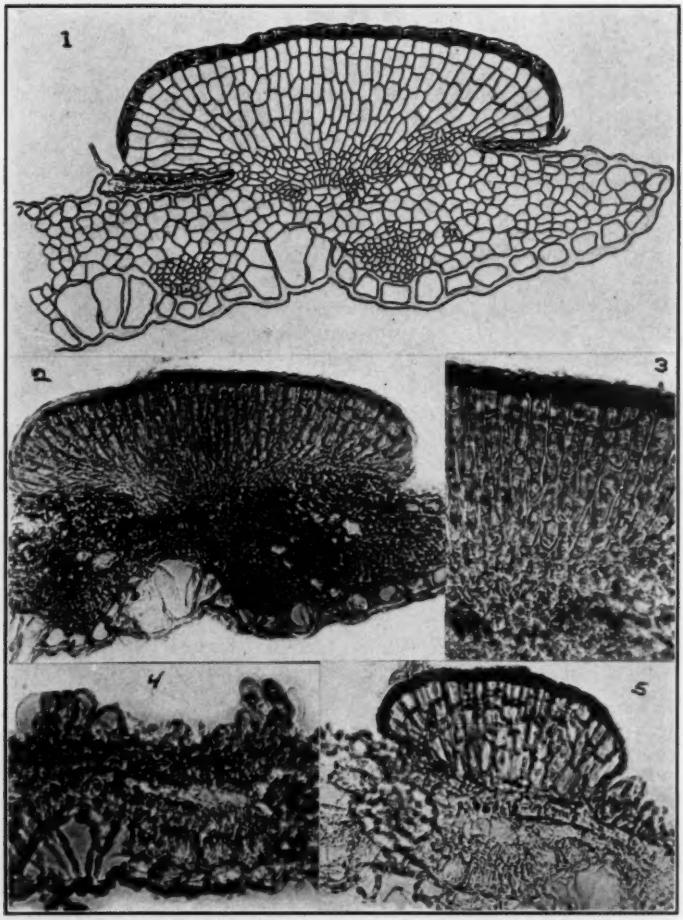
On leaves of *Dendrocalamus strictus* Nees, Lansdowne (United Provinces) September 1934, leg. P. C. Kanjilal (Type); Saharanpur November 1939, leg. O. S. Madan; on *Dendrocalamus* sp. (nec. *Bambusa* sp.), Majhgawan, January 5, 1935, leg. R. N. Tandon (No. *188*, type of *Angiopsora divina*). Also in Tonkin and Japan.

Type deposited in *Herbarium Cryptogamae Indiae Orientalis* of the Imperial Agricultural Research Institute, New Delhi.

Dasturella bambusina sp. nov.

Uredia hypophylla, minuta, pulverulenta; urediosporae ovoideae vel ellipsoideae, tenuiter echinulatae, flavo-aurantiacae vel pallide flavae, 22–29 × 17–21 μ, germinationis poris 2; paraphysibus intermitis, erectis, cylindraceo-capitatis, leviter brunneis. Telia hypophylla, sine peridiis vel paraphysibus, sparse vel aggregata, in maculis nigris foliorum venis parallelis disposita;

teliosporarum capita flabelliformia, 89 to 144 μ alta, 237 to 477 μ diametro; teliosporae sessiles, ex lamina cellulosa, 43–95 × 11–17 μ, eae ex margine superiore crasso apici muro, 4.7–9.3 μ (muri alibi tenues), ex nigro cinnamoneo-brunneae, utrimque 3-, 5-locellatae. Germinationis pori ignoti.



FIGS. 1–4, *Dasturella divina;* 5, *D. bambusina.* Fig. 1, × 296, telial head of *D. divina* (camera lucida); 2, × 225, photomicrograph of same; 3, × 900, part of same more highly magnified; 4, × 225, uredial sorus showing peripheral paraphyses; 5, × 225, telial head of *D. bambusina.*

Hab. in foliis *Bambusae* sp., Mahableshwar, March 18, 1917, leg. S. L. Ajrekar (*Typus*).

Uredia hypophyllous, minute, pulverulent; urediospores ovoid to elliptical, finely echinulate, orange yellow to pale yellow, 22–29 × 17–21 μ, with two germ pores; paraphyses intermixed, erect, cylindrical-capitate, slightly brownish. Telia hypophyllous, without peridia or paraphyses forming rows of black dots parallel to the veins, aggregated or scattered; teliospore-heads flabelliform, 89 to 144 μ in height and 237 to 477 μ in diameter; teliospores sessile, arising from a cellular sheet, 43–95 × 11–17 μ, apical wall 4.7 to 9.3 μ, side walls thin, deep cinnamon brown, 3- to 5-celled. Germ pores not seen.

On leaves of *Bambusa sp.* Mahableshwar, March 28, 1917, leg. S. L. Ajrekar (*Type*). Type deposited in the *Herbarium Cryptogamae Indiae Orientalis.*

The uredia of these rusts do not have a peridium and the urediospores have rather indistinct germ pores at the equator. The teliospores though sessile are not in the form of crust-like masses but are compacted into fan-shaped heads. These characters indicate that the position of the genus is not in the Melampsoraceae but in the Pucciniaceae. The heads are, however, sessible but a genus with sessile heads, *Nothoravenelia,* has already been placed in the Pucciniaceae by Dietel (**1928**) and other genera with sessile teliospores in the same family are *Chaconia, Desmotelium* and *Olivea;* paraphysate uredia are a feature of *Calidion, Desmotelium* and *Olivea* and even some species of *Ravenelia.* Aside from this, the semblance between the heads of *Dasturella* and those of *Ravenelia* and *Nothoravenelia* secures for the genus a position in the tribe Raveneliae of Dietel's (**1928**) classification of the Pucciniaceae.

Species belonging to the genera *Puccinia, Uromyces* and *Angiopsora* were alone recorded on grasses, the status of the genus *Diorchidium,* species of which occur on the Gramineae, not being very clear. Recently a species of *Phakopsora* has been reported on grasses by Cummins (**1941**) *Dasturella* is the fifth genus so far known to occur on the Gramineae, apart of course from the form genera.

We wish to express our thanks to Dr. N. L. Bor, Forest Botanist, Dehra Dun, for his kindness in rendering into Latin the diag-

noses of the new genus and the new species and to Dr. K. Bagchee, Forest Mycologist, and Dr. R. N. Tandon, for placing some of the material at our disposal for study.

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A STEM CANKER OF DOGWOOD AND MADRONA

D. E. Stuntz and C. E. Seliskar

(with 6 figures)

INTRODUCTION

Within the last few years trees of Pacific dogwood, *Cornus Nuttallii* Aud. and madrona, *Arbutus Menziesii* Pursh, in and around Seattle have been affected in increasing numbers with a disease which produces girdling cankers on the stems, and eventually kills the trees. Infected trees have been found near Medina, and in Richmond Beach, Washington, and the disease is quite common in the northern residential district of Seattle, where dogwood and madrona are widely used as ornamentals. In the late summer of 1941 numerous dead and dying trees in the Laurelhurst district of Seattle were brought to the attention of the writers by Dr. J. H. Hanley, director of the University of Washington Arboretum, and it was decided to undertake a study of the disease, to determine its cause, and to investigate the possibility of its control. Some of the results obtained thus far form the basis of this article, and other aspects of the problem are under further investigation by the junior author, who plans a more detailed study of the disease.

DESCRIPTION OF THE DISEASE

The first symptoms commonly noted on dogwood and madrona are a browning and thinning of the leaves in the uppermost crown, followed by complete defoliation and death of the tree. The small twigs and branches at the top of the tree die first. Eventually the larger branches and stem also die. The leaves of infected trees in the upper crown are abnormally small, often chlorotic in appearance, and curled at the edges. Following this condition, the leaves turn brown and are shed. If the trees are killed very suddenly during the summer or early fall before the formation of the abscis-

FIG. 1. Natural canker on *Cornus Nuttallii*. A portion of the surface bark has been removed to show margin and typical discoloration. Note cracking of bark at base of tree.

sion layer, the leaves may remain attached to the twigs long after the normal trees have shed their leaves. Oftentimes the crown will wilt prior to defoliation, particularly during the heat of the summer when transpiration progresses at a fast rate and a sudden interruption of the transpiration stream causes an acute water shortage. This is especially true of madrona, in which the disease is quite virulent.

In both species, the condition of the crown is reflected in a cankerous condition of the stem. In the early stages, the cankers are easily overlooked, particularly on dogwood, where there is little apparent surface discoloration. The presence of a young canker is usually indicated by a sunken or water-soaked bark area. The diseased condition of a stem can be quickly shown by cutting into the inner bark. The infected bark tissue presents a definite discoloration, generally ranging from light brown to a dark or purplish black, as contrasted to the white or cream-colored bark typical of healthy tissue. The differences in discoloration seem to vary with the individual trees. In addition, the outer sapwood is usually discolored, in which case the discoloration may extend to a depth of approximately one or two millimeters. Not infrequently narrow discolored streaks of diseased inner bark and outer sapwood may be found extending some distance beyond the immediate upper and lower margins of the canker. In some cases, these appear only in the outer sapwood and cambium; in others, in both the outer sapwood and inner bark. Although in the early stages the cankers on dogwood are easily overlooked, the young cankers on madrona are readily discernible because of the dark surface discoloration which is very strikingly contrasted to the normal orange-red outer bark.

The canker usually exhibits a definite margin. Following periods unfavorable for the growth of the fungus, this is in the form of a crack between the diseased and healthy tissue. Such a marginal crack usually is found during the winter months. During the periods of vigorous growth, however, the extension of the fungus may not be delimited in this manner. In this case, the margin is very irregular, usually fimbriate and sometimes with small or large finger-like projections (FIGS. 1, 2). Eventually, the dead bark cracks and sloughs off. Oftentimes this is accompanied by a black

FIG. 2. Natural canker on *Arbutus Menziesii*. Surface bark has been scraped away to show margin and characteristic blackening of diseased tissues.

liquid, composed of decomposition material, which oozes from the cracks. This flow of exudate may also occur in the early stages of infection. Soon after, the older portions of the canker are infested with saprophytic organisms and insects.

In the majority of the cases noted by the writers, the cankers apparently started at or near the base of the stem, probably at the root crown. A few cases were noted where the cankers originated at broken branch stubs, indicating that the infection court is not necessarily limited to the base of the tree. It appears that infection is governed by suitable moisture conditions, such as are found in crotches, at the root crown, and other places where moisture is likely to collect.

The rate of spread of the canker is two to several times greater in a vertical direction than in a lateral direction. Cankers that have originated at the base of the tree assume a broadly conical shape, and several such conical projections may be found on a single stem at the apex of a canker. Cankers originating at some distance above the ground are roughly elliptical in shape. The tree is eventually girdled and dies. When cankers were artificially induced, the vertical spread progressed at a rate of two to three times that of the lateral spread for the first four or five weeks, followed later by a more rapid lateral spread and a somewhat lower rate of vertical spread.

While little is known about the pathological anatomy of the disease, investigations are now under way to obtain a more thorough understanding of the biology. The extent of the invasion zone beyond the margin of the canker was tested experimentally in the laboratory in two different ways. Apples were inoculated with bits of bark tissue obtained adjacent to the margin of a canker produced by the disease. The tissue was taken at one-centimeter intervals beginning at the upper extremity of the margin of the canker and extending in a vertical direction into the seemingly uninfected bark. In a like manner, tissue was removed from points adjacent to the lateral margins of the canker and inoculated into apples. In addition, the same method was used in directly inoculating oatmeal agar slants. The results showed no growth on either the apples or agar from bark tissue except when it was obtained from the immediate margin of the canker.

IDENTITY OF THE PATHOGEN

Small bits of tissue taken from the margin of cankers on both madrona and dogwood were placed on agar slants and incubated at 25° C. Pure cultures of two obviously different organisms were obtained in many instances. One of these organisms, later identified as a species of *Phomopsis,* was dismissed from further consideration when inoculations proved it incapable of invading live tissue of either dogwood or madrona. It is to be regarded as a secondary fungus which invades the diseased areas, and may even coexist with the mycelium of the pathogen at the margin of cankers. The other organism was soon shown, by its mycelial characteristics and production of oögonia and sporangia, to be a species of *Phytophthora.* Subsequent tests proved it to be pathogenic to both dogwood and madrona (see below). The necessary data were accumulated for its identification by means of the keys to *Phytophthora* given by Tucker (**6**) and Leonian (**3**). These data are embodied in the description of the fungus given herewith:

Mycelium coenocytic, becoming septate in old cultures, branching profusely in an irregular manner, and bearing an abundance of knobby, wart-like, often fantastically contorted protuberances which may occur in dense, tangled masses. Oögonia 26.2 × 27.2 μ (average of 32 measurements), spherical to pyriform, borne terminally on short lateral branches (FIG. 3); antheridia predominantly paragynous, large, appressed to the base of the oögonium and usually also to its stalk; plainly amphigynous antheridia rather numerous in some mounts, scarce or absent in others. Oöspores 21.8 μ in diameter (average of 32 measurements), borne singly in the oögonium, spherical, with smooth, thick, refringent, hyaline to pale yellowish wall (FIG. 3). Sporangia 32.0 × 40.2 μ (average of 28 measurements), thin walled, hyaline, spherical to subglobose or ovoid, with a prominent papilla, attached laterally or basally to the branches of slender, delicate, sympodially branched sporangiophores, from which they readily become detached (FIG. 4). Germination of the sporangia sometimes by a germ tube, but normally by zoöspores which escape fully formed through the papilla. Chlamydospores infrequently produced, spherical, subglobose or subpyriform, thin walled, not darkening with age, with dense granular contents, closely resembling the sporangia except in their total lack of a papilla.

Abundant growth on oatmeal agar at 20° C. Vigorous colonies on oatmeal agar at room temperatures (20° C.) in 6 days, with the

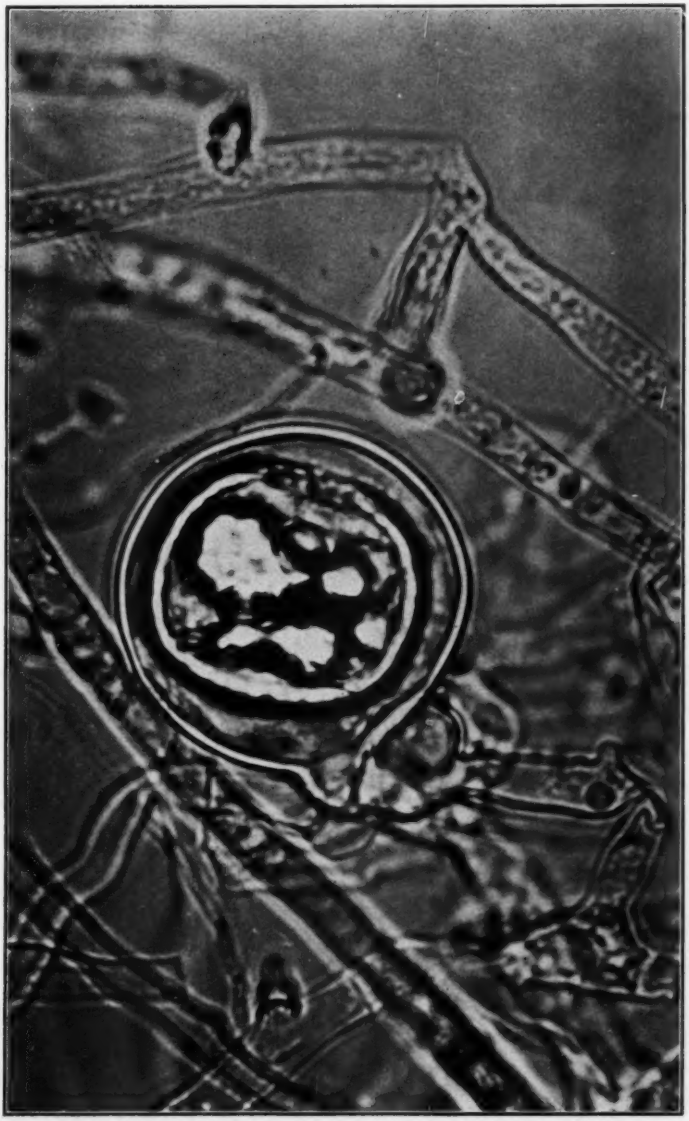

FIG. 3. Photomicrograph of mature oögonium with enclosed oöspore (× 1944). Courtesy of Bror L. Grondal.

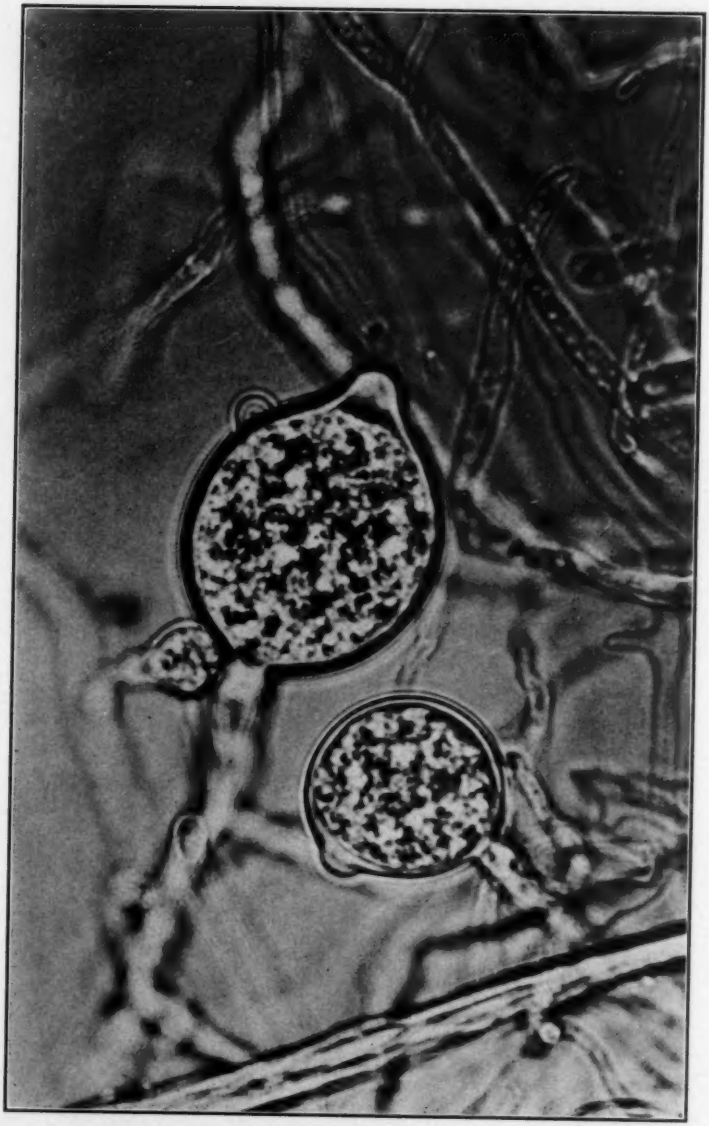

FIG. 4. Photomicrograph of sporangia (× 1250). Courtesy of Bror L. Grondal.

production of abundant woolly aerial mycelium, upon which numerous sporangia appear within 7 days; oögonia appearing later (within 14 days) and chlamydospores still later, if at all. Good growth on malt agar at room temperatures, the colonies thin, appressed, with aerial mycelium sparse and poorly developed, oögonia produced after 10 days. Vigorous growth on cornmeal agar in 4 days at 25°–28° C., the colonies widely spreading, but thin and appressed, resembling those produced on malt agar. Sterile mycelium, grown for three days in pea broth, producing an abundance of oögonia within 48 hours after being washed and transferred to sterile water, and giving rise subsequently to numerous sporangia from which fully formed zoöspores are liberated.

From the above data, it is evident that the fungus is *Phytophthora cactorum* (L. & C.) Schroet., as understood by Tucker and Leonian. *Phytophthora cactorum* is an omnivorous species having a wide host range, attacking species of *Malus, Pyrus, Juglans, Eriobotrya, Prunus,* and many others. This is the first time, however, that *Phytophthora cactorum* has been known to attack Pacific dogwood, *Cornus Nuttallii,* and madrona, *Arbutus Menziesii,* the two most important and widely used native ornamental trees in the Pacific Northwest.

PROOF OF PATHOGENICITY

The proof of pathogenicity in this study is based largely on the results of outside inoculations made on healthy, vigorously growing trees. Twenty carefully chosen trees of Pacific dogwood, *Cornus Nuttallii,* having a diameter range of approximately 3 to 14 inches, were selected for inoculation purposes. In a like manner, twenty trees of madrona, *Arbutus Menziesii,* ranging in diameter from 2 to 10 inches, were inoculated. In addition, a number of trees, representing both species, were selected as controls. Other species inoculated included Oregon maple, *Acer macrophyllum,* red alder, *Alnus rubra,* Scouler willow, *Salix scouleriana,* hazel, *Corylus californica,* and Douglas fir, *Pseudotsuga taxifolia.*

The outside inoculations were made on the stem, root crown, and roots. The two former were made in the following manner: the bark was surface-sterilized with 95 per cent ethyl alcohol and flamed briefly in the immediate area in which the inoculation was made. A boring was then made into the bark to the cambium with

a $\frac{5}{8}$ inch cork borer. Dissecting needles were used to remove the bark disk. A bit of the mycelium, along with a small portion of the agar, was removed from the edge of a vigorously growing culture of *Phytophthora cactorum* and placed in the hole previously occupied by the disk. The disk was then returned to its original place, covering the inoculum. The wound was sealed with grafting wax to prevent excessive drying. All instruments were sterilized with 95 per cent ethyl alcohol and flamed with an alcohol lamp prior to their usage. Oatmeal agar served as the medium for cultures used in the experiment. Controls were carried out in a similar manner, in which sterile agar was substituted for the mycelium. The soil inoculations, however, were made in a slightly different manner. A portion of the soil surrounding the roots was removed, and an incision was made into the bark to the cambium with a sterile scalpel. A small portion of the mycelium was then placed on the fresh wound, after which the soil was replaced. Controls were made in the same fashion, with sterile agar replacing the inoculum. The depth at which the inoculations were made varied with the individual trees, but usually ranged between 3 and 6 inches below the surface of the soil.

Thirteen of the 16 stem inoculations on *Cornus Nuttallii* proved positive and produced cankers similar to those noted on naturally diseased trees (FIG. 5). There was no consistency in the size of the cankers resulting, indicating the possibility of differences in individual tree resistance or the presence of a number of different fungal strains. The average total vertical and lateral spread of the artificially induced cankers on *Cornus Nuttallii* for a period of 13 weeks, from the middle of April to the middle of July, was 7.2 inches and 3.9 inches, respectively. The largest canker had a spread of 20 inches vertically and 6.9 inches laterally. The smallest canker noted measured 2.4 inches vertically and 1.4 inches laterally. The 4 soil inoculations on *Cornus Nuttallii* failed. None of the controls was found positive. Fifteen of the 16 stem inoculations made on *Arbutus Menziesii* produced typical cankers 13 weeks after inoculation (FIG. 6). The average total vertical and lateral spreads measured 17.5 inches and 6.3 inches, respectively. The maximum individual vertical spread was 22 inches and the maximum lateral spread measured was 13.6 inches. Several of

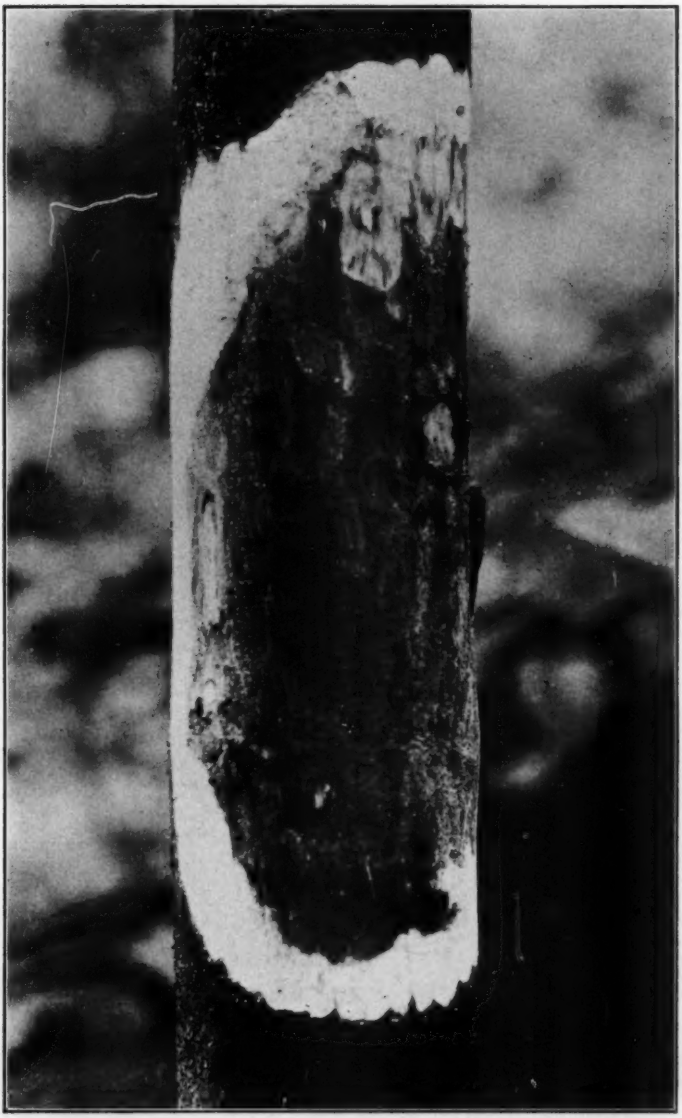

FIG. 5. Artificially induced canker, 7 weeks old, on *Cornus Nuttallii*.

FIG. 6. Artificially induced canker, 11 weeks old, on *Arbutus Menziesii*.

the smaller trees were girdled. The minimum vertical and lateral spreads were found to be 12.2 inches and 2.4 inches, respectively. Two of the 4 soil inoculations proved positive. All of the controls were negative. The reason for the poor success with the soil inoculations on both hosts is probably due to a too rapid drying out of the soil rather than a physiological difference existing in the roots.

All of the other species of trees inoculated with *Phytophthora cactorum* were found more or less susceptible to infection. The pathogen proved quite virulent on *Acer macrophyllum*, and correspondingly less so on *Pseudotsuga taxifolia, Alnus rubra, Salix scouleriana*, and *Corylus californica*, in the order named.

From the inoculation tests it is indicated that the organism is somewhat more pathogenic to *Arbutus Menziesii* than it is to *Cornus Nuttallii*. Field observations of naturally diseased trees appear to bear out this fact.

In addition to the outside tests, inoculations made under laboratory conditions proved positive. Seedlings averaging 3 feet in height were found dead one month after inoculation at the root crown. Inoculations are apt to prove unsuccessful where the greenhouse temperature frequently exceeds 100° F.

When reisolations were made of the organism from the artificially induced cankers of both *Cornus Nuttallii* and *Arbutus Menziesii*, they were found to be identical with the original pathogen.

CONTROL

The extent of the artificially induced cankers was usually determined by cutting away the outer bark to reveal the discolored diseased tissues. Whenever the major part of the diseased area was so exposed, the further spread of the fungus seemed to be appreciably retarded. This observation suggested that scarification of the cankers might afford some measure of control, or at least check the progress of the canker. Accordingly, 6 of the actively spreading artificially induced cankers, 3 on madrona and 3 on dogwood, were treated in the following manner. A strip of healthy tissue approximately one and a half inches wide was removed all around the margin of the canker, exposing the cambium. All dis-

colored tissue, including sapwood, was carefully cut out. The diseased bark of the canker itself was then shaved away. One canker on each host was left without further treatment, but the other two were painted over immediately after scarification with Bordeaux paint (**8**, p. 29). Although not enough time has elapsed since this treatment to make any definite statement as to its ultimate success or failure, it can be said that in every instance the further spread of the canker was halted. The reader should consult the publication of Miller (**4**), and Baines (**1**), who found a similar treatment successful for loquat and apple trees. The lack of a broad invasion zone (see preceeding discussion) and the apparent susceptibility of the pathogen to heat and dryness should make scarification relatively simple, and may offer the hope of saving many valuable ornamental trees, or at least prolonging their life.

Other control measures are being investigated, but definite results have not been obtained.

SUMMARY

Increasing numbers of trees of Pacific dogwood, *Cornus Nuttallii* Aud. and madrona, *Arbutus Menziesii* Pursh., infected with a pathogen which causes serious cankers on the stems, ultimately girdling and killing the trees, are being found in and near Seattle.

The pathogen has been isolated repeatedly and obtained in pure culture from both *Cornus Nuttallii* and *Arbutus Menziesii,* and in all cases it has been identified as *Phytophthora cactorum* (L. & C.) Schroet.

Several trees of both madrona and dogwood were inoculated with pure cultures of *Phytophthora cactorum* obtained from stem cankers, and they subsequently developed cankers identical (in nature and appearance) with those associated with the disease as it occurs naturally. Several of the trees of both species inoculated in the same manner with sterile nutrient agar failed to develop any sign of a canker.

The fungus was reisolated from several of the artificially induced cankers, and found to be identical with the original isolants.

It is therefore concluded that *Phytophthora cactorum* (L. & C.) Schroet., is the cause of a serious stem-girdling canker of *Arbutus Menziesii* Pursh. and *Cornus Nuttallii* Aud.

Several of the artificially induced cankers have been scarified to determine the value of this procedure as a control measure. Although there has not yet been sufficient time to observe the final outcome, the scarification has thus far prevented the further spread of the cankers.

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UNILATERAL STIMULATION OF MICROSPORUM AUDOUINI BY A NEW SPECIES OF BACILLUS

T. BENEDEK [1]

(WITH 7 FIGURES)

During the comparative study of the genus *Microsporum* Conant (1) found that *M. Audouini,* in sharp distinction from *Microsporum lanosum,* does not vegetate at all on rice medium. He thus established a simple, useful and efficient method to differentiate human *Microsporum* from animal *Microsporum,* the differentiation of which due to their varying characters sometimes causes considerable difficulty in giant cultures.

A few years ago during study of a newly discovered species of *Microsporum, M. Stilliansi,* Benedek, 1938 (2) making comparative investigations with *M. Audouini* and several animal species of *Microsporum* on rice medium, I readily substantiated the observation of Conant as to the difference of viability of human and animal species of *Microsporum* on rice.

Rice medium [2] thus became one of the standard and most important mediums in the study of the genus *Microsporum* in my

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[2] Conant (l.c.) prepared the rice medium in the proportion of one part of rice to three parts of water and placed in 125 cc. flasks. The medium was sterilized by exposure to free steam for an hour on two successive days.

I had to change this suggestion. In preparing the rice medium in the proportion 1 : 3 I found that the grains were not softened enough and after a short time the medium, sterile or inoculated, became stone-hard. Sterilized in free steam I always lost a number of flasks due to sporogenous bacilli. Finally in a large serial investigation 125 cc. flasks became so bulky that I had to reduce the size of the flasks to 50 cc. I changed the ratio rice—water 1 : 4 and sterilized 15 minutes at 20 pounds in the autoclave. The rice is softer and can be kept for several weeks without getting hard. Since autoclaving there was no loss of material. This method does not influence the goodness of the rice medium.

laboratory. The re-introduction of natural nutrient mediums may prove as revolutionary in mycological research as the introduction of solid (agar) mediums by Robert Koch proved to be in bacteriology.

As a rule every freshly isolated strain of *Microsporum* goes through rice medium in the process of identification [3] because that is at present the only sure way to exactly differentiate human and animal species of *Microsporum*.

During these routine examinations, a strain of *Microsporum Audouini,* No. 137, was freshly isolated from hair stumps of a negro boy, age 4. I observed that in the primary culture, about 14 days old, a bacterial growth conspicuous by its mustard-yellow color was vegetating along with the fungus. The young primary colony of this strain of *M. Audouini* grew so intimately intermingled with the yellow bacterial growth that a separation of the two microörganisms for the purpose of taking an inoculum for rice medium was practically impossible.

Thus the inoculum transplanted to rice was transmitted along with the yellow bacterial growth. I was fully aware of this fact, but I did not lay any importance upon it, knowing that many bacterial growths do not interfere with the vegetation of hyphomycetes because the latter over-and-outgrow the bacteria.

About five days later on inspecting the rice medium inoculated with strain No. 137, I observed against any expectation and strictly contrary to the experience of Conant and myself—that this strain of *M. Audouini* had begun to grow and later on yielded a luxuriant growth on rice medium.

It was observed that the growth of *M. Audouini* No. 137 on rice was the quickest and most intensive in areas where the mustard-yellow bacterial growth was the most luxuriant. Microscopic examination of the fungal growth revealed (1) the mustard-yellow bacterial growth vegetating along the mycelia, (2) the *M. Audouini* producing many giant septate and non-septate spindle spores, contrary to its attitude on any of Sabouraud's or similar nutrient mediums, where macroconidia usually are sparse or completely missing.

[3] For primary culture I usually use Difco Sabouraud glucose agar, pH 5.6.

Knowing that the strain No. 137 was positively a human strain, *M. Audouini,* and that no *M. Audouini* grows on rice medium, on one hand, and observing the best growth of this strain on rice on the spots with the most luxuriant growth of the bacterial colony, it was quite natural to assume that the presence and only the presence of this mustard-yellow bacterial growth stimulated the *M. Audouini* strain No. 137 to grow on rice.

After many months of painstaking work, two important goals were reached. One was the successful separation of strain No. 137 of *M. Audouini* in pure culture without any concomitant bacterial growth. The second one was the isolation of this mustard-yellow bacterial growth in pure culture. This was more difficult because it was intermingled with *B. subtilis, Staphylococcus albus, Staphylococcus aureus,* and a few more but unidentified cocci and bacterial rods.

Further investigation showed that this vital stimulation is a permanent effect to be elicited at any time and with any strain of *M. Audouini.* It had to be proved that in the primary vegetation of the mustard-yellow bacterial growth (along with shorter and longer, gram-positive and gram-negative, sporogenous and non-sporogenous bacilli and various cocci) only the mustard-yellow pigment producing microörganism was responsible for this unilateral, vital stimulation.

As to the purified, primarily contaminated strain No. 137 of *M. Audouini,* it was easy to prove that this strain did not yield any growth on pure rice medium.

I

To check whether *M. Audouini* does or does not grow on rice in pure strains, ten freshly isolated strains of this fungus were inoculated on rice medium. As usual, the inoculum was a lentil-sized particle of the leathery growth separated as far as possible from the agar nutrient medium and deposited on three different, isolated spots on the rice surface.

Within four weeks, at room temperature (22°–23° C.), no growth took place.

It was conclusively proven that growth of pure strains of *M. Audouini* on rice medium does not take place.

II

Concerning the peculiar stimulating symbiotic effect, two further experiments were carried out.

(*a*) The contaminated strain No. 137 of *M. Audouini* was inoculated again on rice medium, and left at room temperature, to duplicate the first basic observation.

Within three weeks the whole surface of the rice medium was covered with a dense grayish-white fuzzy growth.

(*b*) To ascertain whether this phenomenon occurs only with the contaminated strain No. 137 or other pure strains of this fungus contaminated afterwards with a pure culture of *B. weidmaniensis,* act in the same way pure strains of *M. Audouini* were transferred in the way described above, along with *B. weidmaniensis,* on rice medium.

Within five days the fungus grew well all around the inoculum.

Conclusively the vital stimulation was not an incident, but a constant phenomenon elicitable any time, with any strains of *M. Audouini* contaminated by *B. weidmaniensis.*

III

In this experiment ten freshly isolated pure strains of *M. Audouini* were used. Lentil size inoculums without adhering agar were implanted on three different points on the surface of the rice medium.

These rice cultures were left for eleven days at room temperature. No growth whatsoever took place. The inoculums on the contrary, turned dark brown, they were almost dried up.

On the 12th day the rice grains around the inoculums were infected from a pure culture of *B. weidmaniensis,* three days old, grown on Difco Sabouraud glucose agar, at room temperature.

After 8 to 10 days a vivid growth of *M. Audouini* resulted in each flask around one or two or all three inoculums.

This was a further proof that *B. weidmaniensis,* induces the growth of *M. Audouini* on rice medium.

IV

I prepared rice medium in the usual way and infected it with the pure strain of *B. weidmaniensis,* on three different and distant

points on the surface. After an incubation of 24 hours at 23° C., vegetation of *B. weidmaniensis,* on the rice medium was well visible.

From ten strains of *M. Audouini* in second and third subcultures inoculums were taken and one or two rice flasks were inoculated as usual on all three points showing the presence of the yellow bacterial growth. After six days all the points of inoculation showed growth and after six weeks the whole surface of the rice medium was covered with fungus growth.

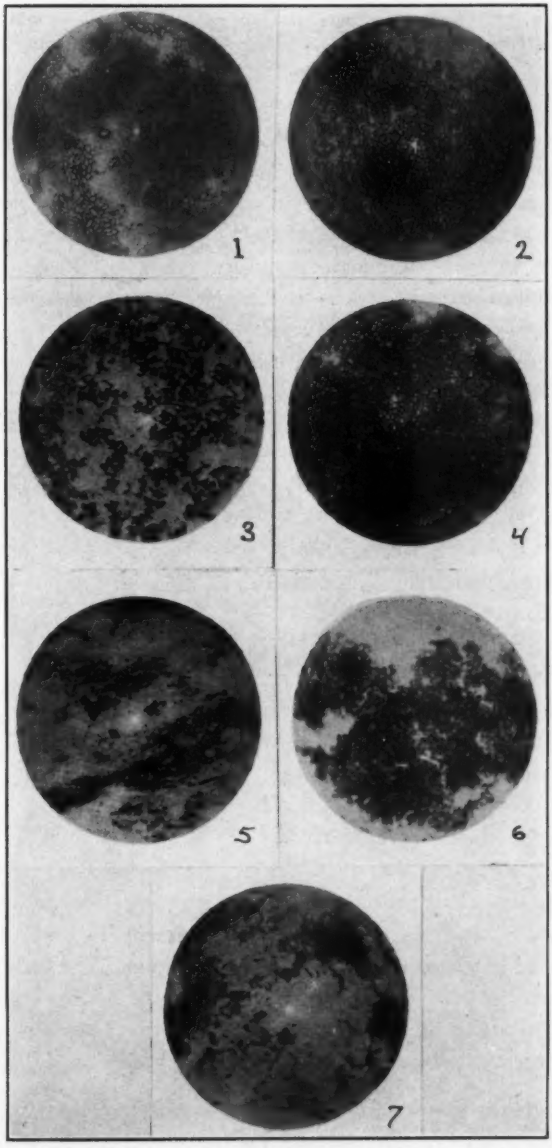
In this experiment double controls were used. *B. weidmaniensis,* on rice alone showed luxuriant growth at room temperature. From all the pure strains of *M. Audouini* used in this experiment, pure rice mediums were inoculated. The latter ones remained without any sign of growth at the end of six weeks at room temperature.

As a further control, *M. felineum* and *M. lanosum* were used. Anytime, whenever repeated, these fungi showed a prompt and luxuriant growth on pure rice medium from the 3rd to 5th day.

B

The unilateral vital stimulation of *B. weidmaniensis,* on *Microsporum Audouini* induced not only a vegetation on rice medium with rich production of large septate and non-septate spindle spores, which are extremely rare or not present at all on Difco Sabouraud glucose agar, but it caused this imperfect fungus to

FIGS. 1–7. *B. weidmaniensis.* 1, grown on Difco Sabouraud glucose agar, 7 days old, at 22° C., stain: methylene blue, microörganisms unstained; 2, grown on Difco Sabouraud glucose agar, 7 days old, at 22° C., stain: methylene blue, microörganisms unstained, rods are here more slender; 3, grown in dextrose broth, pH 6, 7 days old, at 22° C., stain: methylene blue, microörganisms evenly stained; 4, grown on carrot, 7 days old, at 22° C., stain: methylene blue, microörganisms unstained; 5, grown on rice medium, 7 days old, at 22° C., stain: methylene blue, microörganisms mostly evenly stained; 6, grown on carrot, six weeks old, at 22° C., stain: Ziehl-Neelsen spore staining, details in the text, with enlarging glass tiny dots—the spores —are visible at any point of the preparation; 7, grown on blood agar slant, 7 days old, at 22° C., stain: methylene blue, staining is fairly even, microorganisms reveal great polymorphism. All the figures are photomicrograms, taken with Zeiss Phoku, objective: fluorite oil immersion loop, homal 6.2 ×.



FIGS. 1–7.

produce in extreme abundance perfect perithecia. *B. weidmaniensis* was thus the first agent by means of which a medically so important hyphomycete such as the *Microsporum Audouini* could be forced to produce perithecia. The old assumption of Matruchot and Dassonville (**3**), Eidam (**4**), and others that the medically important hyphomycetes are the imperfect forms of Ascomycetes, has thus been proved true, at least for the Microsporum group.[4]

Mycologists may be interested in this peculiar bacterium. It is extremely easy to handle, not having any kind of special or difficult cultural requirements. It need not be transferred oftener than any hyphomycete. The same routine mediums can be used for transfer as generally used in mycology.

Furthermore this bacillus may prove to be of great heuristic value as a biological tool in investigation and in the attempt to induce higher form of fructification in different species of fungi imperfecti.

This discovery may arouse interest in a systematic investigation of the value of different bacteria as unilateral vital stimulating agents in connection with hyphomycetes for the production of higher form of fructification.

The discovery raises more biological questions than can be answered at the present moment. What is the mysterious principle produced by *B. weidmaniensis,* which induces the formation of perithecia? Is this unilateral vital stimulation bound to the living microörganism or can some chemical principles be isolated from its culture causing the same effect? Are there certain cytological differences in the structure of certain mycelia, proper only to a restricted number of mycelia in any thallus still carrying genes of a past and almost forgotten ascomycetic stage? Is any part of a thallus without possible cytological differentiation apt to be stimulated backwards into the ancient primary ascomycetic stage? These are only a few of the questions that arise.

The results already achieved and the problems to be investigated justify the systematic description of this new species of *Bacillus.*

[4] Details on perithecium formation in the genus *Microsporum* are forthcoming in a subsequent publication.

Bacillus weidmaniensis, sp. nov.[5]

I. *Microscopic appearances:* short rods, with rounded ends, 1.5 $\mu \times 2.0\,\mu$–3.0 μ. Protoplasmic contents homogenous, highly refractile. There is no special grouping. Staining reaction: there is no capsule. Simple dye solutions (methylene blue, carbolfuchsin) give slight or no staining at all, depending on the cultural medium. Using 20 per cent tannin solution as mordant methylene blue as counterstain is taken by some, but many individuals are slightly stained or they remain unstained. The bacillus is gram-negative, non-motile and sporogenous.

II. *Growth characteristics:* The growth is quick and luxuriant on all mediums tested. Optimal temperature is 22°–23° C. (room temperature); 37° C. is inhibitory to growth, but when after 48 hours at 37° C. it is put at room temperature again, it slowly recovers and gives a luxuriant culture. Ice box temperature inhibits the growth, too. Fresh inoculums kept at 5° C. for two weeks did not show any growth. But when taken to room temperature, the same tubes yielded luxuriant growth in 48 hours. Aerob, facultative, it produces a mustard-yellow pigment on all synthetic and natural culture mediums.

A. GROWTH ON GELATINE

Stab culture: in plain gelatine only surface growth, no growth in stab, no gas formation. In dextrose and lactose gelatine beside luxuriant surface growth scanty growth in the stab canal with fine gas bubbles in lactose gelatine. The rate of growth is quick on the surface, yielding in 48 hours a 5 mm. glistening plaque with a convex granular center and a flat, smooth, sharply defined periphery. There is no liquefaction within 14 days. Color is mustard-yellow. No odor produced.

B. GROWTH ON AGAR AT 22°–23° C.

(1) Stab: in peptone agar, Difco Sabouraud glucose agar, lactose and glycerin agar there is quick growth on the surface, pin-

[5] *B. weidmaniensis* is deposited under the accession number *8239* at the American Type Culture Collection, Georgetown University Medical School, 3900 Reservoir Road, N.W., Washington, D. C.

point size colonies, very scanty at the upper part of the stab canal; no growth in the deeper part of the canal. No gas formation.

(2) Streak: on pepton agar, Difco Sabouraud glucose agar, glycerin, lactose and beer wort agar, the growth is quick, luxuriant, glistening, the streak is a broad band, sharply defined.

(3) Plate culture: shake cultures yield on pepton agar and Difco Sabouraud glucose agar flat convex, sharply defined, smooth, glistening colonies with ground glass transparency. Deep colonies are of pinpoint size. On beer wort agar superficial colonies are droplet-like, entire, sharply limited, homogenous. Deep colonies are pinpoint to pinhead size.

C. GROWTH IN BOUILLON

In dextrose broth there is thick scum formation of a mustard-yellow color within 24 hours at 22°–23° C. Disturbed the scum sinks to the bottom and forms again. The medium remains clear, there is no odor, the original reaction of the medium (pH 7.2) is not changed within eight days.

In plain nutrient broth the characteristics of the growth depend on the pH of the medium.

At pH 4.5 there is no growth in the first 24 hours. After three days, however, there is slight turbidity, a perfect thin scum and ring formation.

At pH 5.0 and pH 6.0 slight turbidity within the first 24 hours. Slight veil but no ring formation. Crumb-like bottom growth.

At pH 7.0 the turbidity is dense within 24 hours. There is ring formation, fine veil formation and sediment.

At pH 8.0 turbidity is slight again as it was at pH 6.0 with fine mustard-yellow veil formation, ring formation and slight sediment.

After three days plain nutrient broth is entirely clear again.

In unhopped beer wort (unadjusted, pH 5.5), there is slight turbidity within 24 hours, sediment, thin, granular veil formation, no gas formation. After three days absolute turbidity, thick scum formation.

D. GROWTH IN SPECIAL MEDIUMS

On blood agar the streak becomes broad with sharply defined edges, granular surface. Color is at first mustard-yellow, later

turning greenish-yellow. The growth is similar to that on Löffler's serum agar. On potato growth is luxuriant with confluent granular glistening surface. On carrot the millet-size colonies are luxuriant, spreading, glistening. Milk remains unchanged. On rice medium there is a slow growing, thin, glistening mustard-yellow layer. Litmus milk shows slow discoloration, original pH 6.9 changes to pH 6.55 (electrometric) in 13 days. Indol is not formed. Nitrates are not reduced.

E. THERMAL DEATH POINT

It was determined in unhopped wort (unadjusted) pH 5.5. The culture used was one in Difco Sabouraud glucose agar, 48 hours old.

It was found that 85° C. (water bath) in 10 minutes kills the bacillus. Subsequent inoculum on Difco Sabouraud glucose agar yielded no growth.

F. VIABILITY ON ARTIFICIAL MEDIUMS

This microörganism has a remarkable viability on all the mediums tested, liquid or solid. Except for total dryness inoculum gives positive transfers after 3 months and more.

III. MICROSCOPICAL MORPHOLOGY OF THE MICROÖRGANISM ON DIFFERENT LIQUID AND SOLID MEDIUMS AT VARIOUS pH

The most conspicuous microscopical characteristics of this microorganism is its polymorphy depending mainly on the pH of the medium. The second conspicuous feature is the staining property with anilin dyes which is most conspicuous with Löffler's watery methylene blue. It does not take dye at all, giving a negative picture of the microörganisms or if slightly taken, there remains usually in the center of the rod an unstained spot, a well known picture in sporogenous rods.

Because of the confusing polymorphy of this microörganism I found it the best in order to recognize it with certainty and to determine the purity of its culture to use as standard medium Difco Sabouraud glucose agar, pH 5.6. The bacillus yields on

this medium fairly large rods with rounded ends, almost uniform, not staining at all with methylene blue.

This procedure was used to recognize the organism and the purity of its culture from the different liquid and solid mediums. Despite the confusing polymorphy on some of the mediums a retroculture on Difco Sabouraud glucose agar gave always the uniform picture of the microörganism, characteristic for this medium.

A. MORPHOLOGICAL CHANGES OF B. WEIDMANIENSIS IN CONNECTION WITH THE VARIABILITY OF pH IN PLAIN NUTRIENT BROTH

This investigation was carried out in 24 hour old broth cultures at 22°–23° C. (room temperature) with Löffler's watery methylene blue.

pH 4.5. Shorter or longer, thin rods, coccoid or diplococcoid forms. Rarely giant rods or sausage shape individuals. No filaments. Unevenly stained.

pH 5.0. Size, shape, staining property of individuals taken from the scum show the greatest polymorphy.

First there are the always recurring small short thin rods taking methylene blue well and evenly. They are single, in pairs or forming longer chains of 6–12 individuals.

The second most conspicuous individuals are represented by globoid, ovoid or lemon-shape bodies $1.5 \times 1.5\,\mu$ to $2 \times 2.0\,\mu$ showing only a faintly stained contour, the protoplasm remaining entirely unstained. They are single, in pairs or forming short chains of three or more individuals. Many are completely unstained; others, however, show at the periphery, apparently between the outer membrane and the protoplasm, one or two, dot-like, rod-like, or crescent-shape, metachromatically (red) stained corpuscles, sitting equatorially or at the poles. Some show blue or metachromatic bodies, several in number, in a clear unstained protoplasm.

Other peculiar forms are the large thick rods, $3–4.5\,\mu \times 1.5\,\mu$. Many are short, plump, others longer and thick. Straight or slightly (semilunar) curved. Some are sausage-shape or like a

triangle. They are more or less evenly stained blue; but they either show one or more round spots in the body much brighter stained than the rest or there are two or more metachromatic (red) bodies along an axis within the blue area of the protoplasm.

Further, there are thin, long filaments 12.0 $\mu \times$ 1.5 μ, 20–24.0 $\mu \times$ 1.0–1.5 μ revealing more or less conspicuous swelling at one or both ends, or at one or several spots along the thread. They are usually well and evenly stained. Sometimes, however, they show one or more round unstained spots, or only brighter stained spots like a spore.

pH 6.0. The polymorphism is almost entirely stopped. The population of the veil consists almost completely of the usual "normal" short, thin rods, single, in pairs, or in short chains. They are well and evenly stained. Very rare are the unstained globoid or ovoid forms as described at pH 5.0. Infrequently, many large rods and bigger filaments can be found, swollen at one end like a sausage, button-like at the other one or shaped like a spermatozoon.

pH 7.0. The population consists in almost uniformly short thin rods, single or in pairs, or coccoid or diplococcoid forms, partly evenly stained, partly revealing a central unstained spot.

pH 8. Mixed picture: Foremost the coccoid, diplococcoid forms, to a lesser extent thin and short-rods. Staining is poor.

Beer wort 5.5 pH (unadjusted). Short rods (.3 $\mu \times$ 1.5 μ) single or in chain, coccoid or diplococcoid forms. Staining is poor.

B. MORPHOLOGICAL PICTURE OF B. WEIDMANIENSIS ON AGAR, GELATINE, CARROT AND POTATO

This investigation was carried out in 48 hours old cultures, grown at 22°–23° C., pH of the mediums is not adjusted. Each medium has the routinely used pH. Stain: Löffler's watery methylene blue.

(*a*) *Characteristics on agar mediums*

(1) Löffler's serum agar: reveals an extreme polymorphism represented by tiny coccoid forms (0.3 μ), large ovoid bodies and short rods (.3 $\times$ 1.0 μ). Most conspicuous is the staining reac-

tion. Some individuals are entirely stained. Others are very pale blue, while many are not stained at all, showing only a thin pale blue contour. In such individuals there is usually a blue-black dot in the center. Many individuals are stained red (metachromasia).

(2) Blood agar slant: shows similarly a great polymorphism. Tiny coccoid and diplococcoid forms, short thin rods make up the population. Staining: many individuals take the stain very poorly, some are normally stained, but they are always uniformly stained. Size: 2.0 $\mu \times 0.3\ \mu$.

(3) Beer wort agar slant: reveals extremely small coccoid forms and thin short rods, usually deeply stained. The prevalent forms are thick, shorter and longer rods or ovoid forms, entirely unstained, thus giving only a negative picture of the rods, 1.5$\mu \times 3.0\ \mu$ in size. Many show, however, a very pale blue stained tiny dot.

(4) Beer wort agar plate: shows short rods, single or in pairs, or in short chains; individuals with rounded ends, straight rods; exceptionally longer threads. Mostly they are evenly stained, many reveal, however, a brighter stained spot in the center. Size: 1.0$\mu \times 4.5\ \mu$, 1.0$\mu \times 3.0\ \mu$.

(5) Pepton agar slant: population is extremely polymorphous: there are tiny coccoid forms, short rods, plump larger rods, thin filaments 6.0 μ–10.0 $\mu \times 0.3\ \mu$. Many individuals are well stained, some are very pale blue.

(6) Pepton agar stab: shows very short rods, but mainly globoid and ovoid bodies, mostly not taking the stain. They usually show, however, one or two tiny point-like bodies in the unstained protoplasm.

(7) Difco Sabouraud glucose agar: on this medium one has the most typical picture of this microörganism as to its size, shape and its peculiar relation to aniline dyes. The shape and size of the bacillus is almost uniform consisting in short plump rods with rounded ends, not taking methylene blue at all. One has after staining only a negative picture of the contours. Size: 1.5 $\mu \times$ 2.0–3.0 μ.

(8) Glycerin agar streak: reveals almost entirely uniform globoid or slightly ovoid forms; rods are exceptional. Staining leaves

almost uniformly an unstained spot in each individual. Size: $0.5\,\mu \times 0.75\,\mu$.

(9) Pepton gelatine stab: great polymorphism is present: tiny coccoid forms, short thin rods making up the bulk of the population, few large plump rods, sausage-like pairs. Size: $0.3 \times 0.3\,\mu$; $0.5 \times 0.5\,\mu$; $1.0 \times 4.5\,\mu$; $2.0 \times 0.5\,\mu$; $1.5 \times 1.5\,\mu$. They are stained evenly.

(10) Dextrose gelatine stab: population consists of uniform short rods, almost no coccoid forms or larger individuals. Staining is even. Size: $0.5\,\mu \times 2.0\,\mu$.

(11) Lactose gelatine stab: morphology of the population is identical with that on dextrose gelatine stab.

(12) Plain nutrient broth, pH 7.2; the rods are extremely short, reduced almost to ovoid or larger coccoid or diplococcoid forms. There are oftener forms resembling a thick sausage or 2–3 in a row hanging together by a thin thread like a wreath of sausages. Many are evenly stained, particularly the coccoid forms. The rods, especially the longer rods show brighter stained round spots in the center or nearby or they are absolutely unstained. There is no thread-formation. One observes, however, chain-formation consisting of 6–12 individuals. Coccoid forms measure: $1.0\,\mu \times 1.0\,\mu$; $1.5\,\mu \times 1.5\,\mu$; rods: $1.5\,\mu \times 4.5\,\mu$, $1.0\,\mu \times 2.0\,\mu$.

(13) Dextrose broth: morphology of the bacillus is identical with that on plain nutrient broth.

(14) Carrot: the morphology is very impressive. There are short plump rods, globoid or ovoid small bodies not taking the stain at all. In individuals grown on carrot the tiny, deeply stained, point-like body somewhere within the entirely unstained protoplasm is most conspicuous. Size: $1.0\,\mu \times 1.5\,\mu$; $0.3\,\mu \times 0.3\,\mu$; $0.5\ \mu \times 0.5\,\mu$.

(15) Potato: the morphology is entirely different from that on carrot. There are evenly stained short thin rods or ovoid bodies. Many are deeply, others brighter stained. Growth shows a great uniformity in shape and size: $0.3\mu \times 1.5\,\mu$; $0.5\,\mu \times 0.5\,\mu$.

(16) Rice medium: reveals short to very short rods or coccoid forms. There are plenty of sausage-shape individuals, large ovoid forms, chains of large ovoid forms. The short rods and coccoid forms are mostly evenly stained; the large forms take the stain

badly, they show only a pale hue of the stain, oftener they reveal an unstained spot somewhere in the center. Size: 0.3 $\mu \times 0.3\ \mu$; 0.5 $\mu \times 0.5\ \mu$; 1.0 $\mu \times 0.3\ \mu$; 2–3 $\mu \times 2$–3 μ.

Taxonomic position of B. weidmaniensis

The newly discovered microörganism is characterized by rod-shaped cells, production of a mustard-yellow pigment on all mediums—liquid or solid—by extreme polymorphism and definite spore-formation. It is non-motile, aerobic, gram-negative and it does not liquefy gelatine.

The endospore-formation puts this microörganism into the Family V. Bacillaceae Fischer, 1895 and being aerob into Genus I. *Bacillus*.

It is, however, somewhat difficult to demonstrate the spores, because they are extremely small and on certain mediums they show up very lately, if at all. In a six weeks old culture on potato with luxuriant growth one can hardly find spores. For demonstration of endospores an older culture (six weeks and older) of *B. weidmaniensis* on Difco Sabouraud glucose agar is the best.[6]

It could not be identified with anyone of the aerobic, facultative, mesophilic non-motile Bacilli listed in Bergey's Manual.[7, 8]

[6] Spore staining used: mordant: 20 per cent sol. acid. tannic; stain: Ziehl-Neelsen carbolfuchsin; decolorant: 5 per cent sol. acid. sulphuric; counterstain: methylene blue.

[7] Bergey's Manual of Determinative Bacteriology, 5th Edition, 1939, Baillière, Tindall, & Cox, London.

[8] Due to its extreme polymorphism the new species had to be compared most closely with only one species, *Flavobacterium proteus*, Shimwell and Grimes. (J. L. Shimwell, A study of the common rod bacteria of Brewer's yeast. J. Inst. Brewing, 42 (N.S. 33): 119–127, 1936.)

	Flavobacterium proteus	*B. weidmaniensis*
Broth	Turbid in 24 hours at 30° C. with a slight surface scum.	Turbid in 24 hours at 22° C. with thick surface scum and ring formation; medium clear after three days.
Litmus Milk	Unchanged.	Changed.
Potato	A slight, barely visible growth consisting of a narrow filiform dirty yellow line.	Luxuriant growth with intense mustard-yellow color.
Nitrates	Reduced.	Not reduced.

The difference among the two microörganisms are conspicuous.

This new species, on account of its outstanding biological effect on Fungi, is dedicated in honor to the prominent American medical mycologist, Fred. D. Weidman.

COMMENTS

According to *De Bary's* definition, symbiosis is the phenomenon of an intimate and constant association of two generally different microörganisms in conditions which may be considered as mutually beneficient for both.

Van Tieghem (Traité de Botanique, 1891) defined symbiosis as a formation of a single physiologic unit by means of two morphological units. This definition includes the intimate and constant association of two symbiotic organisms without being concerned with the benefit which each one may or may not derive of this association.

With *Papacostas and Gaté* (**5**), we call the phenomenon of symbiosis "stimulative" if two microörganisms cultivated on the same medium *in vitro* reveal a favorable effect as a result of this association. This stimulating effect may be mutual: reciprocal stimulation; or if it effects favorable only one of them: unilateral stimulation. On the other hand, it can effect the development, the vegetation of one of these microörganisms: vital stimulation, or it effects only a microbic function (*e.g.* toxin production, pigment production): functional stimulation.

A. Vital symbiosis

In the present discussion the symbiosis of *Microsporum Audouini* with *B. weidmaniensis,* n. sp., is a unilateral vital stimulation, very similar to the effect of Rhizoctone on Orchid seeds.

Wort	Grows with a pronounced parsnip-like odor.	No odor produced of any kind, on any mediums.
Thermal Death Point	54° C. for five minutes.	85° C. for ten minutes.
Spore-formation	Absent.	Present.
Habitat	Brewer's yeasts.	Scalp of a negro boy.

Noël Bernard's (1904) (**6**) investigations are classical on the germination of the orchids. The seeds of this plant are infected by a fungus (Rhizoctone). In this association the fungus finds its proper nutrient medium on the seed, while, on the other hand, the germination of the seeds to be impossible without the presence of this fungus.[9]

Another example of this phenomenon is revealed by the root nodules of leguminous plants (pea, bean). These nodules are formed by the parenchyma of the root hypertrophied due to the presence of a given species of Nitrobacteriaceae. The benefit is mutual. The bacterium uses the carbohydrates of the vegetable, giving the latter atmospheric nitrogen bound by it.

Papacostas and Gaté summed up in their monograph the scattered data on vital and functional stimulation found in fungi up to 1928. The material is very meager bearing mainly on the symbiosis between yeast and yeast, yeast and bacteria, bacteria and a few species of the family Aspergillaceae.

In the older literature on the subject, I found two important observations not mentioned in the monograph of *Papacostas and Gaté:* the observations of *Molliard* and of *Sartory* having direct connection with my observation on vital symbiosis.

Molliard (1903) (**7**) isolated the *Ascobolus furfuraceus* from cowdung. Starting from ascospores of this fungus in an aseptic way, he got an intense development of mycelium on carrot, for instance, yielding a large number of arthrospores. This fuzzy white mycelium produced perithecia seldom, and when it did they were incomplete and appeared only after 4–6 weeks.

A few cultures, however, had a different aspect. The mycelium formed a veil adhering to the nutrient media, carrot being used.

[9] The existence of a mutually beneficial symbiosis between orchids and certain filamentous fungi was advanced by N. Bernard in 1904 and subsequently supported by Burgeff (1909, 1911, 1936), Costantin (1917) and Ramsbottom (1922, 1927). Lately J. T. Curtis (1939) offered evidence that the orchid-fungus relation is non-specific. He believes that the symbiotic relationship is one of parasite and host, with the orchid deriving no benefits from the fungus in its roots. (Cf. J. T. Curtis: The relationship of specificity of orchid mycorrhizal fungi to the problem of symbiosis. Am. Jour. Bot. **26**: 390–399, 1939; Knudson: Bot. Gaz. **73**: 1–25, 1922 and ibidem, **89**: 192–199, 1930.)

These cultures produced perithecia within 10–15 days in abundance. On microscopic examination it was seen that there was a "bacterium" (not named) vegetating along with the mycelium.

Afterwards he isolated this "Bacterium" and the fungus in pure culture. When sterilized cow-dung was first infected with the bacterium and inoculated afterwards with the fungus (*Ascobolus furfuraceus*), this culture always yielded abundant perithecia.

No explanation is attempted of the dynamics of this phenomenon.

Molliard's observation (1903) is, I believe, the first one concerned with production of perithecia in Ascomycetes as a result of interference of a Bacterium in a unilateral vital stimulation. It is well known, that saprophytic ascomycetes in pure culture seldom produce on any medium anything but sterile mycelium or conidial fructification, almost never perithecia.

A. Sartory (1916) (**8**) isolated an *Aspergillus* from humid straw and feather of a crow, nearly identical with *Aspergillus B.* var. *Scheelei* Bainier Sartory.

Transplanting conidia and mycelium (contaminated culture) to sterilized wet straw he got the form *Eurotium* (ascogenous form of *Aspergillus*) at the end of about ten days. The number of perithecia was large, golden-yellow in color, variable in size, the largest ones being between 90 μ and 100 μ in diameter. The perithecium was cleistocarp, the asci carrying eight ascospores, 4.5 $\mu \times$ 5.5μ, oval, from profile with a furrow.

After having isolated this *Aspergillus* in pure culture, the perithecium formation ceased entirely and it could not be elicited on any kind of synthetic or natural (leather, straw, carrot, potato, etc.), mediums. This author remembered, however, of having isolated along with the *Aspergillus* a bacterium from the group of *B. mesentericus.*

Having inoculated this bacterium with the *Aspergillus* he permanently got the form Eurotium provided the bacterium did not reach an extensive vegetation. Optimal temperature was at + 22° C.[10]

[10] I tried to duplicate this experiment of Sartory using *Aspergillus flavus* and *B. mesentericus* on rice medium. I failed. I succeeded, however, in producing perithecia in *Aspergillus flavus* by means of *B. weidmaniensis* on rice medium.

Sartory assumed with *Pinoy* that the *B. mesentericus* only "modifies" the nutrient media for the *Aspergillus* without any other kind of biological interference. In my opinion this biological phenomenon is far more complicated than that.

B. Vital antibiosis

Antibiosis, a term introduced for the first time by *Vuillemin,* in 1889, was also observed in fungi. Some experiments were carried out mainly on yeasts and bacteria, to a lesser extent between bacteria and hyphomycetes and here again mainly in the family Aspergillaceae.

When the association of two microörganisms in vitro have an inhibitory effect, we call it, with *Papacostas and Gaté,* antibiosis. This may be mutual or unilateral. If this condition effects the development, the vegetation of one of them: vital antibiosis; if some function is inhibited or disturbed (*e.g.* pigment or toxin production) : functional antibiosis.

During the investigation on vital stimulation between *M. Audouini* and *B. weidmaniensis,* I observed instances of definite antibiosis between *M. Audouini* and several bacterial species originally present in the mixture of bacterial growth. *B. subtilis, Staphylococcus aureus* and *Staphylococcus albus* had a unilateral vital antibiotic effect on *M. Audouini,* absolutely impeding the growth of any pure strain of *M. Audouini* even on glucose agar medium.

The phenomenon of symbiosis and antibiosis among microorganisms finds more and more interest among mycologists and bacteriologists.

Chambers and Weidman (**9**) found interesting instances of vital antibiosis. In their experiments *Bacillus subtilis* entirely inhibited *Trichophyton interdigitale* in thirty-four of forty tests and restrained it in the remainder. The same vital antibiosis was found if they used *Bacillus subtilis* in association with *Trichophyton purpureum, T. gypseum, T. asteroides, T. pedis, T. acuminatum, T. lacticolor, Microsporum lanosum, M. Audouini, T. violaceum, Sporotrichum schenkii.* All ten species were completely inhibited and have remained so up to the drying point of the substrate. Blood agar was used as nutrient medium throughout these experiments.

P. A. Ark and Marjorie L. Hunt (**10**) recently called attention to the phenomenon of bacterial antibiosis. They isolated a number of bacterial species which were antagonistic to phytopathogenic microörganisms in varying degrees. Special attention was given to two soil bacteria which showed a strong antagonism both to bacteria (gram-positive and gram-negative) and to certain fungi.

SUMMARY

Conant's observation that *Microsporum Audouini* does not grow on rice medium in contradistinction with any other known species of the genus *Microsporum* was fully confirmed.

The incidental observation of the presence of a yellow pigment producing microörganism in the primary culture of a strain of *Microsporum Audouini* led to the discovery of *B. weidmaniensis,* and to the evidence of the phenomenon of a unilateral vital stimulation between these two microörganisms.

In the presence of *B. weidmaniensis, Microsporum Audouini* does grow on rice medium and in certain instances it does even produce perfect perithecia.

The mustard-yellow pigment producing, spore-bearing bacillus, *B. weidmaniensis,* is distinct morphologically and physiologically from all the known species of the Genus *Bacillus.* Its full description is given.

B. weidmaniensis is the first representant of the Genus with the distinct property of unilateral vital stimulation on Fungi.

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MYCOLOGICAL NOTES FOR 1939–40 [1]

L. O. Overholts

(with 7 figures)

This paper is a continuation of a series with similar title begun in 1919 and continued until the present time. They represent an attempt to call attention to the new and unusual fungi encountered from year to year, especially those inadequately known or lacking complete descriptions and illustrations.

I. PHYCOMYCETES

Synchytrium aureum Schroet.

This species of the order Chytridiales is known on many hosts; the addition of another is hardly to be classed as astounding. However in June, 1940, while collecting near St. Marys, Elk Co., Pa., several plants of *Trientalis americana* were discovered which appeared to be infested by a fungus of the *Synchytrium* type. Perusal of the literature showed no such host for any member of the Chytridiales. Specimens submitted to W. W. Diehl were named as belonging here. The fruiting of the fungus did not affect the growth of the plants which were in full flower. The fungus was fruiting on the stems and on and near the midribs of the leaves.

II. ASCOMYCETES

Dasyscyphella vitis (Schw.) Rehm.

This interesting fungus has seldom been collected since its record by Schweinitz. It is probably not an uncommon species, and was picked up in three widely separated localities in Penn-

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sylvania during the 1940 collecting season. The first of the three collections was verified by Miss Cash of the Division of Mycology, who pointed out the similarity of the fungus to *Erinella miniopsis* (Ellis) Sacc. The spores were measured as 80–90 × 2.5 μ. They are at first multiguttulate and then multicellular. The habitat is the dead outer bark of living trunks of *Vitis*. All of the collections were made in June.

MOLLISIA PTERIDINA (Nyl.) Karst.

In pulling up the dead and overwintered leaf bases of *Dicksonia punctilobula*, a small white Discomycete, scarcely as much as 200 μ diameter, sessile or attached by a very short stem, was discovered. Miss Cash later determined it as probably referable to the above name. The spores are 5–7 × 1.5–2 μ, 1-celled, and hyaline. The name has apparently not previously appeared in the American literature. The collection was made May 20, 1940, in Stone Creek Kettle, Huntington County, Pa.

MOLLISIA REVINCTA ALBO-PALLIDA Rehm.

On June 11, 1940, I collected rather abundantly a small Discomycete which Miss Cash determined for me as fitting the description of the above species and variety. It was growing on the bases of dead raspberry canes in a moist ravine near Salladasburg, Lycoming County, Pa. The following notes were made:

Apothecia crowded or scattered, sessile, not erumpent, 1–2 mm. broad, externally minutely pubescent with a slightly brownish pubescence, the disk with margin elevated at first, then plane, isabelline to light avellanaeous; asci 40–50 × 5–7 μ, cylindric-clavate, sessile, 8-spored; spores biseriate, hyaline 1-celled, sometimes slightly curved, 9–12 × 2.5–3 μ; paraphyses simple, filamentous, about 2 μ diameter, neither strongly enlarged nor conspicuously pointed at the apices.

The species has not previously been recorded from America.

MYCOSPHAERELLA TYPHAE (Lasch) Lindau.

On dead leaves of *Typha latifolia*, Carbon Twp., Lackawanna County, Pa., Oct. 15, 1935.

Perithecia amphigenous, non-maculicolous or producing only a slight blackish discoloration in the immediate vicinity of the scattered perithecia which are black, globose, 60–70 μ diameter, with a thin but distinct blackish wall; asci 30–36 $\times$ 10–12 μ, 4-spored; spores narrow-elliptic, smooth, hyaline, 2-celled, 11–13 $\times$ 4–4.5 μ.

The fungus grew intermixed with a *Cladosporium* and was found only near the tips of the leaves.

PECKIELLA GEOGLOSSI (Ellis & Ev.) Sacc.

This species may be more common than this first collection of mine would indicate. It first forms a mold-like growth over its host and in this stage is a *Verticillium* with oblong conidia that are hyaline, 1-celled, 10–16 $\times$ 5–6 μ. The mycelial mat then becomes more compact and forms a subiculum (stroma?) on which perithecia are produced, seemingly almost superficially. Ascospores 9–14 $\times$ 3–4 μ. The fungus is reported by Seaver as occurring in New Jersey and New York. It was collected in the Forbes State Forest, Westmoreland Co., Pa., Aug. 1, 1940. The deformation of the host, while considerable, allows the maturing of the ascospores so that the host species can be determined. Seaver describes appendaged spores for the genus *Eleuthromyces,* in which he places this fungus. Careful examination of many spores, especially in the younger stages, does not substantiate this character. I take it to belong better in *Peckiella,* where Saccardo referred it, in spite of the nearly or quite superficial perithecia. Neither does my material show one to three spores on the conidiophores, as Rabenhorst states, but always a single spore on each.

PEZICULA RHODODENDRICOLA Rehm.

On dead *Rhododendron maximum,* Stone Creek, Huntingdon Co., Pa., July 5, 1920. J. W. Groves made this determination and states that this is the first American material he has seen. Apparently this is the first report of the species from America.

SPHAERULINA TAXICOLA (Peck) Berl.

The following notes were made from two collections on *Taxus canadensis* on Roaring Branch, Lycoming Co., Pa., April and May,

1938. The earlier collection was immature; the latter mature. The fungus was originally described from New York. The affected needles were dead but yet on the plant, and the appearance was that of a parasite.

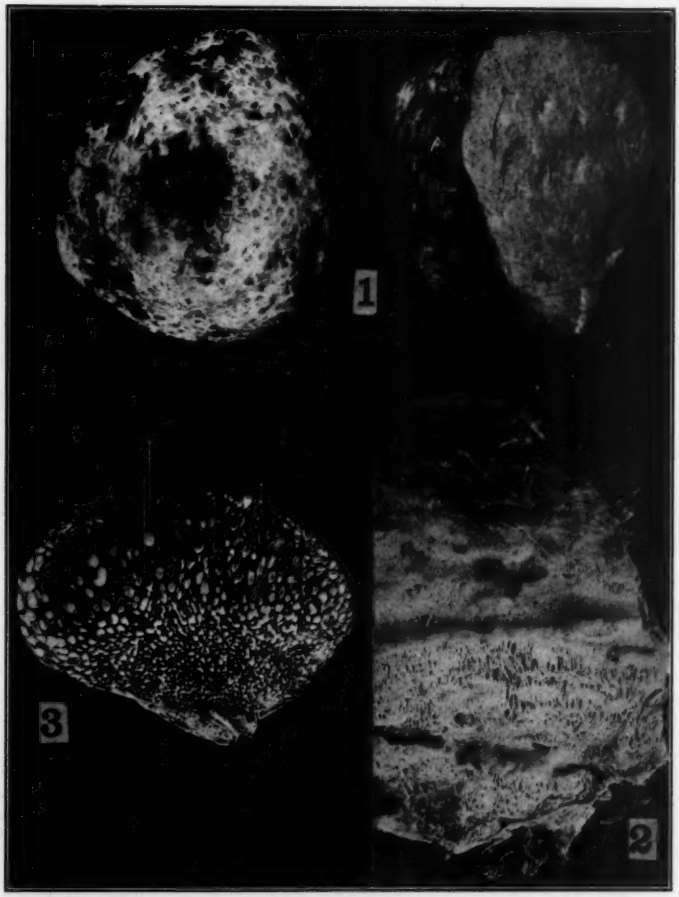

FIG. 1, *Tuber candidum*, surface and sectional views of the ascocarps (× ⅔); 2, *Poria grandis*, type specimen (× 1); 3, *Pisolithus tinctorius*, sessile form of the species, lateral view of vertical section, showing peridioles (× ⅔).

Perithecia abundant, crowded, epiphyllous, black, 80–100 μ diameter, definitely subepidermal or cortical in position, with a well developed black wall; asci 60–80 $\times$ 12–14 μ; spores biseriate, hyaline, 4-celled, the ends pointed, 18–20 $\times$ 10–12 μ; paraphyses none.

The species is apparently rare in Pennsylvania.

TUBER CANDIDUM Hark. (FIG. 1).

The finding of a species of this family is an event in the lives of most mycologists. Hence it was with great surprise and pleasure that two specimens were discovered on the mossy bank of a small mountain stream in Center County, Pa., in October, 1939. The specimens were larger than the usual records for this species, the largest being 6.5 cm. diameter. The fruiting bodies were only about half-imbedded in the soil.

BASIDIOMYCETES

UREDINALES

PUCCINIA KUHNIAE Schw.

Arthur reported in 1934 that it was doubtful if *P. Kuhniae* occurred in Pennsylvania, though much earlier reported by Schweinitz. Since it was known that Schweinitz made a trip to the vicinity of Hope, Indiana, and since the rust is known from that region and had never been collected east of about that point, it was postulated that Schweinitz had erred in attributing a collection from that region to a Pennsylvania locality. However, in 1939, the rust was collected in quantity on *Kuhnia eupatorioides* near Pleasant Gap, Center Co., Pa., by J. P. Kelly and H. A. Wahl. Though this does not substantiate specifically the Schweinitz record, it makes it seem much more probable.

UROMYCES ANDROPOGONIS Tracy.

In a 1929 rust bulletin by Kern et al. it was stated that this rust was known from Pennsylvania only from the collections of Schweinitz. At Benezette, Elk Co., Pa., it was collected in 1940 on *Viola striata,* which is also an unreported host for it in Pennsylvania. The aeciospores are definitely smaller than those of

Puccinia Violae and *P. Ellisiana* from which *U. Andropogonis* is otherwise indistinguishable in the aecial stage.

AGARICALES

FISTULINA PALLIDA Berk. & Rav.

This interesting and rare species was collected on the campus of The Pennsylvania State College by J. W. Sinden, Oct. 30, 1939. This is the only specimen I have ever seen. It was immature, but duplicates almost exactly Atkinson's Plate 65, figure 2. Apparently it cannot be mistaken for the common species, *F. hepatica.*

PISOLITHUS TINCTORIUS (Pers.) Coker (FIGS. 3, 4).

This interesting and unique species is reported by Coker only from North Carolina, South Carolina, Florida, and Alabama. It was collected on the campus of The Pennsylvania State College in September 1939 by Morton Lange of Denmark. The identification was verified by Coker. On July 11, 1940, another collection was brought in by J. W. Sinden. The former collection was of the sessile type; the latter was rather distinctly stalked.

Poria cognata sp. nov.

Effused in patches 8–10 mm. or more broad, scarcely separable except in small pieces, somewhat nodulose but probably because of the irregularities of the substratum, the sterile margin and sterile subiculum pale yellow, submembranous but inclined to be somewhat cheesy; subiculum distinct but thin, up to 0.5 mm. thick as seen in sections; pore surface cream-color to gray when fresh, becoming more sordid and isabelline with a slight yellowish cast when dry, the tubes oblique, up to 5 mm. long where best developed, often shorter, the mouths often gaping, thin-walled, entire, averaging 2 to 3 per mm. or larger in the gaping types; spores short-cylindric, the ends pointed, smooth, hyaline, $5–6 \times 2\,\mu$; cystidia none; subiculum hyphae densely interwoven, not staining well, somewhat branched, $2.5–3\,\mu$ diameter, probably with cross walls and clamps but these very indistinct; taste bitter.

Type collected on stump of *Castanea dentata,* on the trail to Mt. LeConte from Gatlinburg, Tenn., Aug. 15, 1939.

Poria grandis sp. nov. (FIG. 2).

Broadly effused, soft-membranaceous, separable, at first entirely pale sulphur-yellow, the sterile margin and subiculum remaining so in dried specimens, elsewhere pale avellaneous or grayish on drying, with small yellowish mycelial strands that penetrate the rotten substratum; subiculum tissue evident, soft, tough, yellow; tubes not more than 1 mm. long, yellow within, the pore surface at first

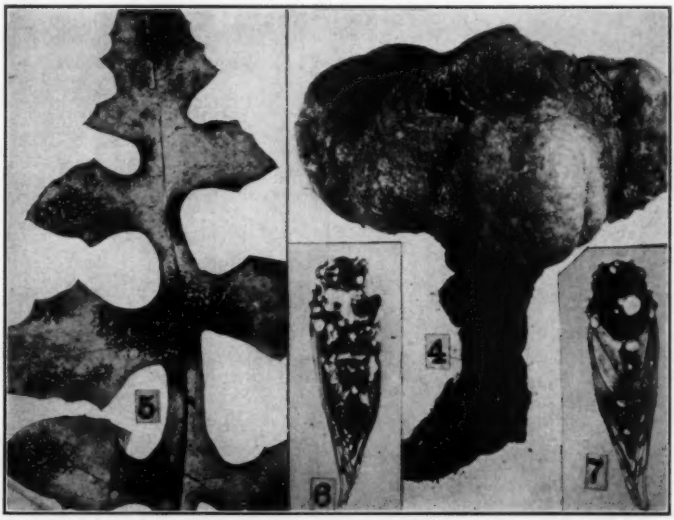

FIG. 4, *Pisolithus tinctorius*, surface view of a stalked sporophore (× ⅗); 5, *Asteroma Lactucae* (× 1); 6, *Beauveria globuliferae*, ventral view of cicada and fungus (× ¾); 7, top view of cicada and fungus (× ¾).

pale yellow, whitening at maturity, but on drying becoming isabelline, the pores obliquely gaping or more regular, angular, thin-walled, entire, averaging about 3 per mm.; spores ellipsoid to broadly ellipsoid, smooth, hyaline, 3–4 × 2–3 μ; cystidia none; hyphae of subiculum 3–4.5 μ diameter, all thin-walled, septated and clamped.

Type collection from the under side of much rotted logs of coniferous trees, near Gatlinburg, Tenn., in the Great Smokies National Forest, Aug. 19, 1939. Collected by J. A. Stephenson.

FUNGI IMPERFECTI

ARTHROBOTRYUM ATRUM Berk. & Broome.

This fungus is well represented in Saccardo's Fungi Italici, figure 12. I get no more than a suggestion that the large central part of the spore is separated into two cells by a septum. Also, it is difficult to tell whether the hyaline stalk cell is a part of the spore or not. I marked the substratum in the field as the stem of *Sambucus canadensis,* but if it is that species, the host died at a very early stage in its growth in the spring. The collection was made in the Great Smokies National Forest, near Gatlinburg, Tenn., Aug. 15, 1939.

ASTEROMA LACTUCAE J. J. Davis (FIG. 5).

Apparently not much is known about this fungus. Superficially it gives the appearance of black anastomosing veinlets but under the lens this character is less distinctive. There is no necrosis of the leaf tissue (at least at this stage) and the black reticulum is present on both leaf surfaces but better developed on the upper than on the lower surface. No fruiting bodies are present and Dr. Davis described the same condition for his collection. It was collected on living leaves of *Lactuca* near the Pennsylvania-Maryland state line on U. S. Route 40, July 15, 1938. The determination was made by J. A. Stevenson.

BEAUVERIA GLOBULIFERA (Speg.) Picard (FIG. 6, 7).

Each year an infestation of the 17-year locust occurs I have watched closely for evidences of fungi on their dead bodies. In the summer of 1940 such an infestation of the locusts appeared over certain areas of central Pennsylvania. In September a single specimen was found infected with a white mold that proved to be this species of fungus. It formed white superficial pads of mycelium, 0.5–2 mm. diameter, particularly in the thorax region, but more or less over the whole body. Spores globose or nearly so, 1.5–2.5 μ diameter, hyaline, one-celled. Collected at Ross Run, Huntingdon Co., Pa., Sept. 1, 1940.

CORNULARIA HISPIDULA (Ellis) Sacc.

This species illustrates how easily a common fungus may be overlooked year after year until accident flashes it before the eye in such a way that it cannot be ignored. On the morning of June 16, 1940, I stopped the car along the highway near Trout Run, Pa., and stepped into the woods with collecting basket. A shower a few hours before had left the woods dripping. The early morning sun put the lighted side of tree trunks in sharp relief. Before me stood a living *Nyssa sylvatica* sapling with trunk covered with small black spine-like fruiting bodies of a fungus that was later identified as *Cornularia hispidula*. Other nearby saplings of the same species were likewise covered by it. A few days later I looked for it at my mountain cabin on Ross Run, Huntingdon Co., Pa. A *Nyssa* sapling within 20 feet of the building was the first location for it and later it was substantiated as present generally in the region. However, the fungus is common apparently only on trees of a certain age, or at least with a certain stage of roughening of the bark. On older rougher barked saplings it has not been found and likewise its absence from smooth barked individuals has been substantiated. Saplings about one to one and a half inches in diameter seem to be most preferred. The species has since been found over a wide area in Pennsylvania. It was originally described from New Jersey (as *Sphaeronema*). The spores are elongate, usually slightly curved, attenuate at both ends but much more so at one end than at the other, 8–9-celled, the tip cells colorless, the others brownish, 60–80 × 4–4.5 μ.

LEPTOTHYRIUM KELLERMANI Bubak.

On dead overwintered leaves of *Sassafras officinale*. Stone Creek, Huntingdon Co., Pa., April 30, 1940.

Pycnidia amphigenous, scattered, appearing as minute black disks, 120–160 × 40–50 μ, the walls thick and black; conidiophores hyaline, 15–20 × 1.5–2 μ; conidia minute, bacilliform, hyaline, 1-celled, 3.5–4 × 0.75 μ.

It does not seem impossible that this is the spermagonial stage of some species of *Mycosphaerella*, perhaps *M. Sassafras* Ellis & Ev.

Myxosporium castanicolum sp. nov.

Acervuli scattered, erumpent, surrounded by the broken epidermis, up to 640 μ diameter as seen in sections, from the surface view appearing much smaller, internally with a broadly conic mound of stromatic tissue that is fertile on the outer surface; spores elongate-ellipsoid, smooth, hyaline, 1-celled, 24–28 $\times$ 9–11 μ.

Type collected on dead twigs of *Castanea mollissima* at Hamford, Conn., and communicated to me by T. T. Ayers (Overholts Herbarium *21609*).

If Peck's spore measurements of *M. castaneum* Peck are correct, this fungus could not be referred to that species.

NAEMOSPORA ALNI Allesch.

This was collected on dead *Alnus* branches in Stone Creek Kettle, Huntingdon Co., Pa. The specimens were determined by W. W. Diehl. Apparently the fungus comes in quickly after the death of the host. The collection was made on May 20 and the branches of the host had been broken off during the preceding winter. The pycnidial cavities were overlaid by what seemed to be young stromata of an Ascomycete but no asci had yet been formed. This is probably the first report of this species for Amercia. The spores are somewhat smaller than reported in the literature, measuring 8–9 $\times$ 1.5–2 μ.

PERICONIA PYCNOSPORA Fres.

This interesting fungus, almost unknown from America, was picked up in Elk Co., Pa., June 17, 1940, on overwintered dead stems of *Eupatorium purpureum*. The fungus answers the description in almost every detail. Conidia 11–14 μ diameter, with considerable evidence that they are formed in chains, as noted in Lindau's description in Rabenhorst's Kryptogamen-Flora.

PHYLLOSTICTA NYSSAE Cooke.

Though spots have been noted on leaves of *Nyssa sylvatica* for many years, no fungus responsible for them has been seen by me until this year. The following notes were made:

Spots 5–12 mm. diameter, circular, more conspicuous from above than from below, at maturity dull gray brown with a broad purplish red margin; pycnidia minute, 45–60 μ diameter, epiphyllous, numerous, black; conidia minute, cylindric, bacilliform, 3–3.5 $\times$ 1 μ.

The description of the spots as given by Seaver is not adequate, and spores with the measurements he gives would not likely be described as "ellipsoid to sub-ellipsoid." It may be the spermatial stage of some Ascomycete rather than a valid *Phyllosticta.*

SPORODESMIUM PEZIZA Cooke & Ellis.

A *Sporodesmium* collected in Westmoreland Co., Pa., on dead *Acer rubrum* (decorticated) in 1940 was determined as this species by D. H. Linder. Apparently the same fungus as the above was described by Peck a year or two later as *Septonema bicolor,* as acknowledged by Peck. A characteristic dark red coloration in KOH has not been previously mentioned for this species. The spores are in chains and all stages in development are shown in my collection, from the colorless few-celled condition to the dark multicellular condition. They therefore vary greatly in size up to 80μ in length and 40 μ in width. The clusters of conidia and conidiophores form discomycete-like bodies up to 0.5 mm. diameter on the surface of decorticated wood.

Stilbella acerina sp. nov.

Inhabiting spots in conjunction with *Phyllosticta accricola,* the coremia epiphyllous, about 1 mm. high, erect, dark brown, 20–40 μ diameter below, enlarged at the apex to as much as 120 μ diameter, fertile only at the tip; spores elliptic, smooth, hyaline, 1-celled, 4–5 $\times$ 2–2.5 μ.

On living leaves of *Acer rubrum.* The type specimens were collected at Gatlinburg, Tenn., near the entrance to the Great Smokies National Park, Aug. 18, 1939.

Stilbella Hamamelidis (Van Hook) comb. nov.

A collection of this species was made in Forbes Forest, Westmoreland Co., Pa., on leaves of *Hamamelis virginiana,* Aug. 2, 1940. The fungus simulates *Gonatobotryum maculicolum* as

viewed under a lens but the spots are different. Microscopically they are, of course, easily separated. It was originally described as a *Graphium* and there is some question of its proper generic position. The hyaline spores and hyaline hyphae making up the upper part of the coremium indicates *Stilbella* as does also the production of spores in a mass of mucus—*i.e.*, a small droplet at the apex of each conidiophore. The brown hyphae making up the lower part of the coremium argues for the genus *Graphium*. Few if any species of *Graphium* are parasitic on leaves. Van Hook's species seems to have not yet been compiled into the Sylloge. I am indebted to W. W. Diehl for confirming my own opinion on the identity of the fungus. Van Hook says the fungus occurs in Indiana, Ohio and New York.

STATE COLLEGE, PA.

NOTES AND BRIEF ARTICLES

The Mycological Collections of the Bureau of Plant Industry, including the C. G. Lloyd Mycological Collection, have been moved from Washington to new, permanent quarters at the Bureau of Plant Industry Station, located 13 miles north of the Department of Agriculture Buildings in the District of Columbia, on the Baltimore-Washington Highway near Beltsville, Maryland. The collections as part of the Division of Mycology and Disease Survey are housed on the ground floor of Building 5. The Field Station is accessible from Baltimore and Washington by two bus lines and from the latter city by interurban. It is of course readily reached also by those so fortunate as to be able to drive their own cars. The collections with supporting indexes have been arranged and are available for consultation and study.—J. A. STEVENSON.

HAPLOSPORANGIUM BISPORALE

Thaxter,[1] in 1914, described a new genus, *Haplosporangium*, with two species, *H. bisporale* and *H. decipiens*, the first species being characterized by two spored sporangia, the second by one spored sporangia. The species *H. bisporale* is of interest because in so far as the writer knows it is the only species with two spored sporangia, and in the fact that no other record of its occurrence has been reported.

While culturing out ground squirrel dung which had been collected at Rocky Arbor State Park, Wis., for the purpose of obtaining any *Mucorales* present, I noted a small fungus growing in the maze of other molds which produced strands of very fragile hyphae which were fertile for long distances. Along these free hyphae many short sporangiophores arose bearing minute sporangia, some of which were branched others were not. The points of attachment of the sporangia were very small, the bases of the

[1] Thaxter, R. New or peculiar Zygomycetes 3: *Blakeslea*, *Dissophora*, and *Haplosporangium* Nova Genera. Bot. Gaz. **58**: 353–366. 1914.

sporangiophores were very large. This immediately reminded one of the figures given by Thaxter for his *Haplosporangium bisporale*. Upon examination it proved to be this species.

It was readily isolated by picking off mature sporangia on to various kinds of agar. On both corn meal and potato dextrose agar sporulation was slow and very scanty to none. However on Czapeck agar though growth was very scanty many spores were rapidly produced. Still more successful was potato dextrose agar to which rat dung was added, this produced much aerial growth and a great deal of sporulation.

Mycelium on these various kinds of media is white, delicate, consisting of fertile and sterile portions, the fertile portions seem chiefly to be aerial producing many sporangiophores for a long distance, or in other places only one to a few sporangiophores may be present. The sporangiophores arise on all sides from the main hyphal strand and at right angles to it. Strands bearing sporangiophores show numerous constrictions dividing it into segments. Sporangiophores are 66–36 μ in length, the average 48 μ, width at the base from 4–9 μ, on the average 7.5 μ, the tips about 1 μ, and often bent backward, usually with one or two branches, the branchlets short and very small at more or less right angles to the main sporangiophore. Single spored sporangia 11–7.25 μ, sporangia bearing two spores, 12–14 μ. The bisporus sporangia in water mounts show a distinct surrounding membrane, the two spores at first are flattened on one side in the sporangium, however, upon release from the sporangium they tend to round up and take on an oval shape.—C. W. HESSELTINE.

NOTE

Persoon, C. H. Icones Pictae Specierum Rariorum Fungorum. Paris et Strasbourg. 1803–1806. 4°. 64 pp. 24 tab.

In Bibliographical Contributions from the Lloyd Library (vol. 3, No. 2, pp. 54, July 1917) the above publication is listed by C. G. Lloyd as one of the three rarest of Persoon's works. Only five American mycological libraries are known to possess complete copies of it. Recent correspondence has revealed that others have imperfect copies lacking the fourth fascicle, composed of pages

45–64 and colored plates 19–24. In order to complete a copy at Cornell University lacking the fourth fascicle, the photographer of the Department of Plant Pathology, Mr. W. R. Fisher, has copied the indicated missing pages and plates. Kodachrome films have been used for the colored plates, and, from these, color prints from wash-off relief film have been obtained. Both the pages of the text and the plates have been made full size suitable for binding with the first three fascicles of the original. The cost has not proved excessive and has been shared by two other institutions to whom prints have been provided. We are willing to make additional sets of prints for others at a reasonable price. As the negatives will be discarded after a few months, it is urged that librarians interested examine their copies promptly. Requests for prints or additional information should be addressed to:

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